10 Measurement

LEARNING SEQUENCE

10.1 Overview

Why learn this?

Measurement, together with geometry, is important in our everyday lives. We are able to describe objects using numbers and units of measurement, such as millimetres, centimetres, grams and kilograms. How far is it from your home to the nearest beach? What is the size of a tennis court or a football ground? How long is a cricket pitch? How much sugar is in your favourite cookie? All of these questions and thousands more are answered using measurement.

When we measure objects we need to understand the units of measurement. Which is longer, a centimetre or a millimetre? Can you change centimetres to millimetres and millimetres to centimetres? From stump to stump, a cricket pitch is 20.12 metres or 2012 centimetres or 20120 millimetres!

Olympic swimming pools need to be 50 metres long and 25 metres wide. Builders must know these dimensions before constructing a pool. Before anything can be made, you need to decide how small or large it will be — that is, its dimensions or measurements. We use measurement to describe length, perimeter, area, volume and capacity every day. Can you imagine trying to build your home without first knowing what its size will be? Many professionals use measurement in their day-to-day work. Among these are property developers, builders, engineers, designers, dressmakers, chefs, architects and construction workers.

DISCUSSION

Why is it important to have an international standard metric system? Which countries don't follow this system?

Where to get help

Go to your learnON title at **www.jacplus.com.au** to access the following digital resources. The Online Resources Summary at the end of this topic provides a full list of what's available to help you learn the concepts covered in this topic.

Exercise 10.1 Pre-test

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Complete this pre-test in your learnON title at www.jacplus.com.au and receive **automatic marks**, **immediate corrective feedback** and **fully worked solutions**.

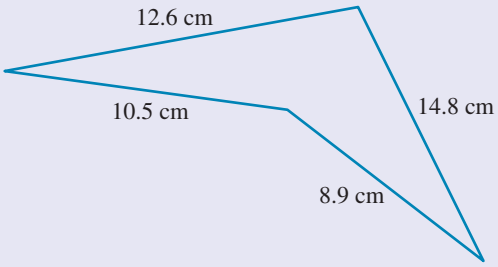
1. Convert 0.565 m into cm.

2. If the length of a cricket pitch is 20.12 m, calculate its length in km.

3. If the height of a city building is 36 m and it measures 10 cm in a photo, calculate how tall a building that measured 25 cm in a photo would be in real life.

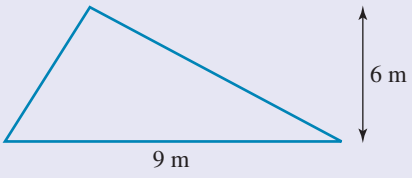
4. Luca went for a training run that was 1200 strides long. If each of his strides was 1.5 m, calculate the total distance he covered.

5. Determine the perimeter of this figure.



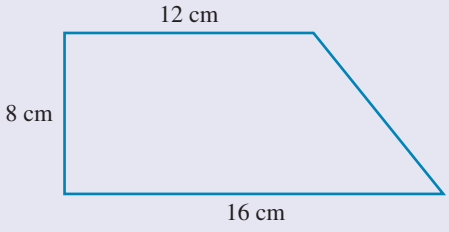
6. A rectangular pool has a perimeter of 34 m. If a concrete border of width 2 m was laid around the pool, calculate the perimeter around the outer section of the concrete border.

7. Determine the area of the triangle at right.



8. A rectangular room with dimensions 3.5 m by 6 m is to be carpeted at a cost of $22.50 per m^2.
Calculate the total cost to carpet the room.

9. Calculate the area of the figure at right.



10. A rectangular wall 6.2 m by 2.4 m is to be painted.
A rectangular cabinet 1.8 m by 1.2 m rests against this wall.
The area to be painted does not include the area of the cabinet.
Calculate the area of the wall to be painted.

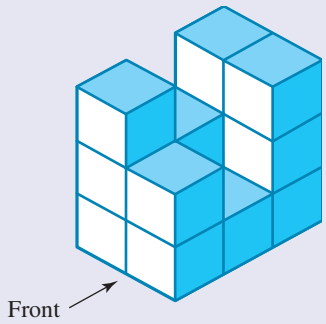
11. Calculate the volume of a rectangular prism with a length of 8 m, a width of 3 m and a height of 2 m.

12. A rectangular prism has a volume of 112 cm^3.
If it has a height of 2 cm and a width of 8 cm, determine its length.

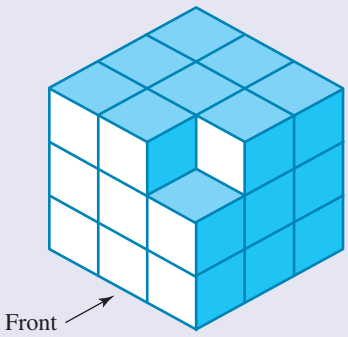
13. A rectangular sink has a length of 45 cm, width of 40 cm and a depth of 30 cm. Calculate the sink's capacity, in litres.

14. Match the following three-dimensional shapes to their plan views.

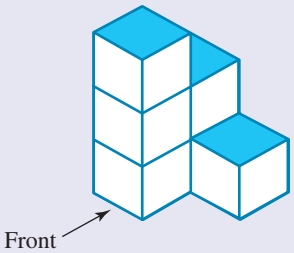
a.



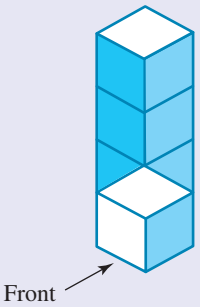
b.



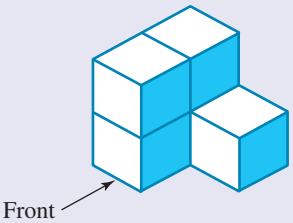
c.



d.

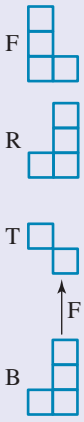


e.

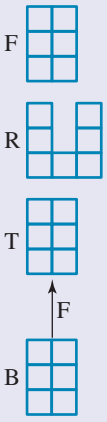


Plan views:

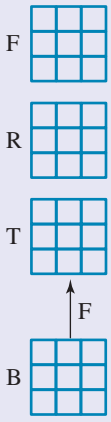
i.



ii.

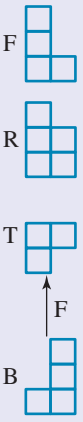


iii.



iv.

v.



15. Select the correct shape that represents each of the following views.

a. MC The top view of a telephone pole

A. Oval **B.** Circle **C.** Trapezium **D.** Rectangle **E.** Triangle

b. MC The top view of the Sydney Cricket Ground

A. Oval **B.** Circle **C.** Trapezium **D.** Rectangle **E.** Triangle

c. MC The side view of a bucket

A. Oval **B.** Circle **C.** Trapezium **D.** Rectangle **E.** Triangle

d. MC The top view of a car

A. Oval **B.** Circle **C.** Trapezium **D.** Rectangle **E.** Triangle

10.2 Units of measurement

LEARNING INTENTION

At the end of this subtopic you should be able to:

- convert between different units of length.

10.2.1 Metric units of length

eles-4549

- The metric system is based on the number 10.
- The base unit of length of the metric system is the metre.
- The following figures show the most commonly used units of length along with their abbreviations and photos showing approximate examples.

1. Kilometre (km)

One kilometre is the distance travelled in one minute by a car travelling at a speed of 60 kilometres per hour.

2. Metre (m)

The length of an adult's stride

3. Centimetre (cm)

The width of each of your fingers

4. Millimetre (mm)

The width of a wire in this computer chip

DISCUSSION

Where do you use measurement in your everyday life?

WORKED EXAMPLE 1 Identifying the most appropriate unit of length

You have been given the task of measuring the width of an A4 page. State which metric units of length you would use.

THINK

Estimate the length involved. In this case, it will be less than a metre and more than a centimetre. Consider which unit would be easiest to use. If you use metres, the width would be expressed as a decimal. If you use centimetres, the width would be expressed as a whole number. Therefore, centimetres is the best choice of unit.

WRITE

Centimetres (or cm)

eles-4550

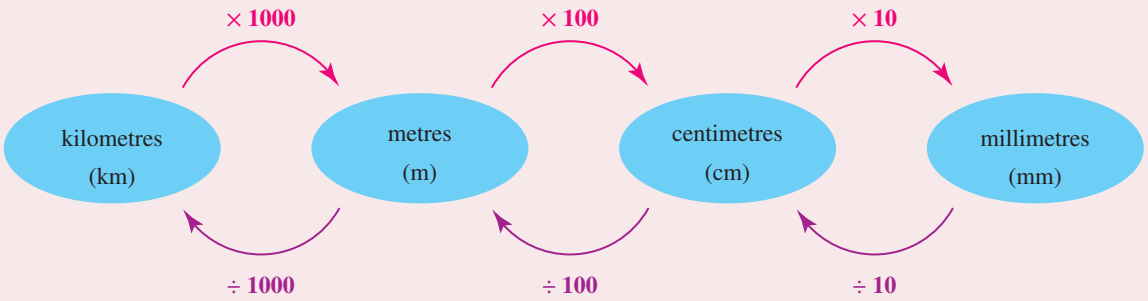
10.2.2 Converting units of length

- The main metric units of length are related as follows:

$$1\text{ km} = 1000\text{ m} \quad 1\text{ m} = 100\text{ cm} \quad 1\text{ cm} = 10\text{ mm}$$

Unit conversion

Units of length can be converted as shown in the following diagram. The numbers next to each arrow are called **conversion factors**.



- When converting from a larger unit to a smaller unit, multiply by the conversion factor.
- When converting from a smaller unit to a larger unit, divide by the conversion factor.

WORKED EXAMPLE 2 Converting units of length

Complete each of the following metric conversions.

a. 0.3285 km = _____ m

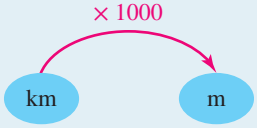
b. 560 m = _____ mm

c. 480 cm = _____ km

d. $2\frac{3}{5}$ m = _____ cm

THINK

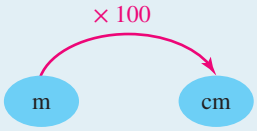
a. To convert kilometres to metres, multiply by 1000. (Move the decimal point 3 places to the right.)



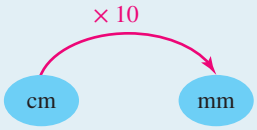
WRITE

a. 0.3285 km = 0.3285 × 1000 m
= 0.3285
= 328.5 m

b. To convert from metres to centimetres, multiply by 100 (since there is no decimal point, place two zeros after the final digit).



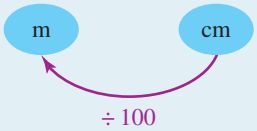
To convert from centimetres to millimetres, multiply by 10 (place one zero after the final digit).



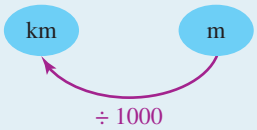
Note: Overall, we need to multiply by 100×10 or 1000.

b. $560\text{ m} = 560 \times 100\text{ cm}$
$= 56\,000\text{ cm}$
$= 56\,000 \times 10\text{ mm}$
$= 560\,000\text{ mm}$

c. To convert from centimetres to metres, divide by 100 (move the decimal point 2 places to the left).



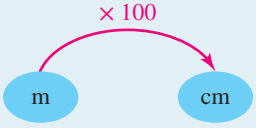
To convert from metres to kilometres, divide by 1000 (move the decimal point 3 places to the left).



c. $480\text{ cm} = 480 \div 100\text{ m}$
$= 4.8\text{ m}$
$= 4.8 \div 1000\text{ km}$
$= 0.0048\text{ km}$

d. 1. Convert $2\frac{3}{5}$ m to an improper fraction.

2. Convert metres to centimetres by multiplying by 100.



Note: Remember when multiplying fractions by a whole number, the number multiplies the numerator.

3. Simplify the fraction.

d. $2\frac{3}{5}\text{ m} = \frac{2 \times 5 + 3}{5}\text{ m}$
$= \frac{13}{5}\text{ m}$
$= \frac{13}{5} \times 100\text{ cm}$
$= \frac{1300}{5}\text{ cm}$
$= 260\text{ cm}$

Resources

eWorkbook	Topic 10 Workbook (worksheets, code puzzle and project) (ewbk-1911)
Digital documents	SkillSHEET Metric units of length (doc-6505) SkillSHEET Measuring the length of a line (doc-6507) SkillSHEET Relationship between unit size and the number of units used (doc-6508) SkillSHEET Converting units (doc-6509) SkillSHEET Converting units to compare lengths and distances (doc-6510)
Interactivities	Individual pathway interactivity: Units of measurement and converting units of measurement (int-4355) Metric units of length (int-4010) Converting units of length (int-4011)

Exercise 10.2 Units of measurement

learnON

Individual pathways

PRACTISE	CONSOLIDATE	MASTER
1, 3, 4, 6, 9, 14, 16, 18, 20, 25, 28	2, 5, 7, 11, 13, 15, 17, 22, 23, 26, 29, 30	8, 10, 12, 19, 21, 24, 27, 31, 32, 33, 34

To answer questions online and to receive **immediate corrective feedback** and **fully worked solutions** for all questions, go to your learnON title at www.jacplus.com.au.

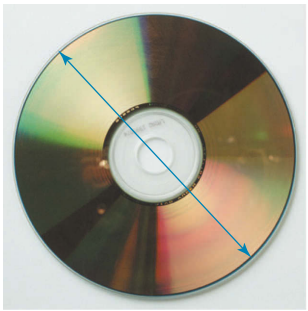
Fluency

1. WE1 State which metric units (mm, cm, m or km) would be most suitable for measuring the real lengths marked in each photograph.

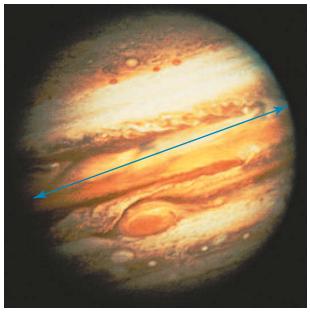
a. The length of a large kangaroo

b. Large distances between towns

c. The diameter of a DVD



d. The diameter of a planet



e. The height of a tall building

2. State which metric units of length you would use for measuring the following.

   a. The length of a netball court
   b. The diameter of a netball
   c. The distance between Melbourne and Sydney
   d. The thickness of a magazine

3. MC Select which unit you would use to measure and compare the thicknesses of two different brands of chocolate biscuits.

   A. millimetres
   B. kilometres
   C. metres
   D. centimetres
   E. kilometres or metres

4. WE2 Complete each of the following metric conversions.

   a. 2.0 km = _____m
   b. 7.0 km = _____m
   c. 5.3 km = _____m
   d. 0.66 km = _____m

5. Complete each of the following metric conversions.

   a. 0.25 m = _____cm
   b. 28.0 cm = _____mm
   c. 200.0 cm = _____mm
   d. 700.0 m = _____cm

6. Convert to the units indicated.

   a. 8000 m = _____km
   b. 6500 m = _____km
   c. 700 m = _____km
   d. 50 m = _____km

7. Convert to the units indicated.

   a. 6000 cm = _____m
   b. 57 cm = _____m
   c. 45 mm = _____cm
   d. 25 600 mm = _____cm

8. Convert to the units indicated.

   a. 8 km = _____cm
   b. 101 m = _____mm
   c. 72.33 m = _____mm
   d. $30\frac{7}{20}$ mm = _____m

9. MC Identify which of these distances is the same as 6.25 km.

   A. 625 m
   B. 0.006 25 m
   C. 625 000 mm
   D. 625 000 cm
   E. 62.50 cm

10. MC Identify which of these distances is the same as 7 860 000 cm.

    A. 78.6 km
    B. 786 m
    C. 786 km
    D. 786 000 cm
    E. 7.86 km

11. Convert to the units indicated.

    a. $45\frac{1}{5}$ m to km
    b. 560 mm to m
    c. $8\frac{3}{4}$ cm to mm

12. Convert to the units indicated.

    a. 0.0006 km to cm
    b. $3\frac{9}{100}$ km to cm
    c. 48 mm to cm

Understanding

13. Give an example of a length that each of the following people might measure in their jobs. (For example, a carpet layer would measure the length of a room.)

    a. Veterinary surgeon
    b. Costume designer
    c. Carpenter
    d. Landscape gardener
    e. Field athlete

14. The longest snake ever held in captivity was a female reticulated python named Colossus. She measured 8.68 m long. The shortest species of snake, the West Indian *Leptotyphlops bilineatus*, only grows to 108 mm. Write, in centimetres:

a. the length of the longest snake
b. the length of the shortest snake.

15. The world's highest mountains are Everest (8848 m) and K2 (8611 m). Convert these heights to kilometres.

16. Arrange the following in order from smallest to largest.

a. 12.5 m, 150 cm, 0.02 km
b. 350 cm, 0.445 m, 3000 mm
c. 50 km, 500 m, 50 000 mm

17. Arrange the following in order from smallest to largest.

a. 1700 cm, 1.7 m, 0.17 km
b. 0.052 cm, 0.0052 mm, 0.000 052 m
c. 990 cm, 0.909 m, 9000 mm

18. Add the following lengths, giving your answer in the specified unit.

a. 75 cm and 3 m: cm
b. 2700 m and 7.5 km: m
c. 1.66 m and 58.2 cm: cm
d. 0.000 675 km and 87.8 cm: cm

19. Calculate the difference between each of the following lengths, giving your answer in the specified unit.

a. 72 km and 5600 m: m
b. 418 000 mm and 7.6 m: m
c. $34\frac{3}{5}$ cm and $\frac{9}{20}$ m: cm
d. $2\frac{4}{5}$ km and 450 000 cm: km

20. The tallest building in Dubai is the Burj Khalifa, which stands 0.828 km high. Convert this height to metres.

21. A builder needs to build a wall 3.5 m high. If each layer of bricks adds 8 cm of height, calculate how many layers of bricks are in the wall.

22. Deanne buys a length of rope and cuts it into three smaller sections, each of length 7200 cm.
Calculate how long the original piece of rope measured.

23. Norbert is 1.53 m tall in bare feet. If he wears shoes with soles that are 6.3 cm thick, calculate how tall he is when wearing these shoes, in metres.

24. Adrian is driving a truck with a rooftop 3.4 m above road level when he approaches an overpass bridge that has a clearance of 376 cm. Determine whether Adrian's truck will fit under the bridge. If so, state the room he has spare, in centimetres.

Reasoning

25. Zvenglo is stacking identical boxes of height 330 mm. Calculate the height of a stack of six boxes, in centimetres.

26. Finita attaches a trellis that is 0.6 m high to the top of her 180 cm high fence. Calculate the height to the top of the new trellis from ground level. Give your answer in metres.

27. Astronomers use light-years as a measure of distance in the universe. A light-year is the distance travelled by light in one year. If light travels approximately 300 000 km in one second, calculate the distance travelled by light in:

a. **i.** one minute **ii.** one hour
iii. one day **iv.** one year (365 days).

b. Explain why astronomers use this measurement for distance rather than kilometres.

Problem solving

28. A pin, 14 mm long, is made of wire. Determine how many whole pins could be made from 1 km of wire.

29. A licorice strap machine takes 3.80 m lengths of licorice and chops them into 10 cm long pieces. Determine how many pieces each 3.80 m length produces.

30. Waldo's noticeboard is 1.5 m long and 1.2 m wide. If he pins a calendar of length 70 cm and width 60 cm exactly in the middle of the board, determine the distance from the top of the calendar to the top of the noticeboard. (*Hint:* Draw a diagram of the situation.)

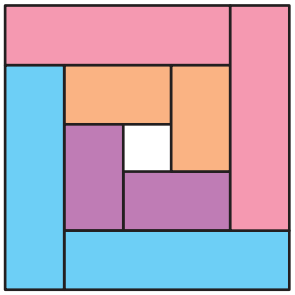
31. A childcare centre has three large cardboard boxes that the children stack up in various combinations. What stack heights are possible if the boxes' individual heights are 600 mm, 45 cm and 1.1 m? Give your answer in centimetres.

32. A mother and daughter are riding their bikes to the local market. The circumference of the mother's bike wheel is 2 m while the circumference of the daughter's bike wheel is 1 m.

a. Calculate the number of rotations of the wheel there are in 100 m for the:
i. mother **ii.** daughter.

b. Calculate the number of rotations of the wheel there are in 1 km for the:
i. mother **ii.** daughter.

33. In a 'log cabin' quilt, a pattern is created from a series of squares and rectangles. From a centre square, 4 congruent rectangles are placed to build a larger square. This process is repeated a number of times to build larger and larger squares. Laurel starts with a centre square of side length 2 cm. If each rectangle has a width of 2 cm and a length that depends on its position in the block, give the dimensions of the rectangles that will need to be cut if the final block is to be 18 cm square. (Don't worry about seam allowance.)



34. It is said that the average person walks the equivalent of four times around the Earth in a lifetime. The circumference of the Earth is about 40 000 km. If you lived to age 80, approximate the number of kilometres per week you would walk to achieve this distance.

10.3 Reading scales and measuring length

LEARNING INTENTION

At the end of this subtopic you should be able to:

- read and interpret various scales.

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10.3.1 Reading scales and measuring length

- A **scale** is a set of levels or numbers used to measure length, mass, temperature or any other quantity.

Reading scales

When reading scales and measuring lengths:

- check that the scale starts with zero
- check the value of each small division by counting along the scale to the next major mark
- always give units (for example, centimetres or kilograms) with your answer.

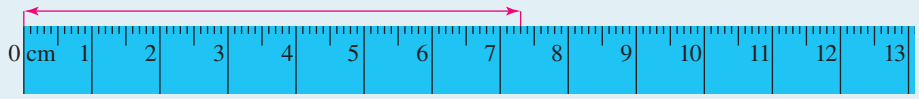
WORKED EXAMPLE 3 Reading a scale

State the reading indicated by the arrow, giving answers in:

i. decimal form **ii. fractional form where appropriate.**

a.

b.



THINK

a. i. 1. Check that the line starts at 0. It does.

2. Note the units printed on the ruler (cm).

3. Read the last centimetre mark (5).

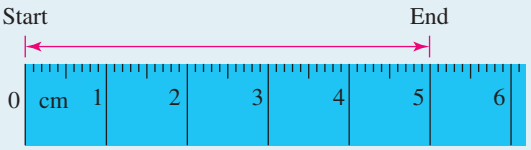
4. Does the line go past the last centimetre mark? No.

5. Write the answer with units.

ii. There is no need to write in fractional form as the value is a whole number.

WRITE

a. i.



5 cm

b. i. 1. Check that the line starts at 0. It does.

2. Note the units printed on the ruler (cm).

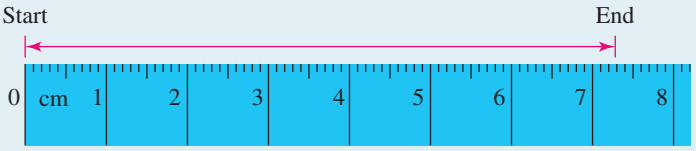
3. Read the last centimetre mark (7).

4. Consider how many smaller intervals (or divisions) there are between each number. There are 10, so each smaller division represents 0.1 of a unit.

5. Count the number of small divisions past the last centimetre mark (3).

6. Write the answer with units.

b. i.



7.3 cm

ii. Express the answer obtained in **b i** as a fraction. Recall the conversion of decimals to fractions.

ii. $7.3 = \frac{73}{10}$ cm

Or, $7\frac{3}{10}$ cm

WORKED EXAMPLE 4 Applying a scale

Use the given length of the climber's lower leg to estimate the labelled length of the rope in the following diagram.

THINK

1. Refer to the 0.5 m lengths indicated on the diagram and determine how many of these lengths correspond to the unknown length of the rope above the climber.
Note: There are approximately $3\frac{1}{2}$ or 3.5 of these lengths in the rope.

2. Multiply the number of lengths by 0.5 m.

3. Write the answer.

WRITE

From the diagram there are approximately $3\frac{1}{2}$ (or 3.5) of these lengths in the rope.

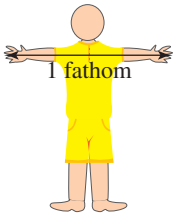
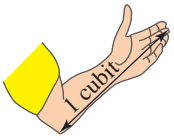
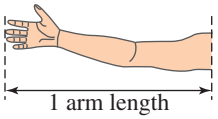
$\text{Length} = 3.5 \times 0.5$
$= 1.75$

The length of the rope is approximately 1.75 m.

COLLABORATIVE TASK: Using your body to estimate lengths

To help improve your ability to estimate lengths, you can use different parts of your body for reference.

1. Use a ruler or a tape measure to measure the following distances and complete the following table.

	Digit width	Handwidth	Fathom	Cubit	Arm length
Picture of measurement					
Your measurement					

2. Complete the following sentences.
   a. One metre is _____.
   b. The bottom of my knee is _____ off the floor.
3. As a class, select a range of objects around the room and:
   a. estimate the dimensions simply by looking at the object
   b. estimate the dimensions using a body part as a reference
   c. measure the dimensions using a ruler or tape measure.
4. Make a table, like the following one, to record your data for each object. A sample is shown.

Object and dimension	First estimate	Number and type of body part unit	Estimate using body parts	Length, using a ruler or tape measure
Height of door	190 cm	$23\frac{1}{2}$ handwidths	$23.5 \times 7.5\text{ cm} = 176.25\text{ cm}$	180 cm
Length of pen				

5. List some other body dimensions that you could use to estimate length: for example, the distance from the tip of your nose to the end of your outstretched arm, or the length of your foot.
6. Use a ruler or tape measure to measure these distances on your own body.
7. As a class, discuss whether the measurements that you made were exact measurements or approximations.

on Resources

eWorkbook Topic 10 Workbook (worksheets, code puzzle and project) (ewbk-1911)
Digital document SkillSHEET Reading scales (doc-6506)
Interactivities Individual pathway interactivity: Reading scales and measuring length (int-4356)
Scales and measuring length (int-4012)

Exercise 10.3 Reading scales and measuring length

learnON

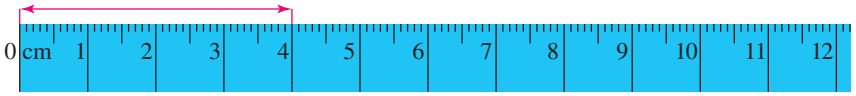
Individual pathways

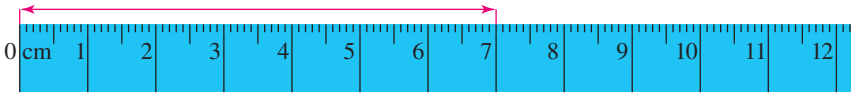
PRACTISE	CONSOLIDATE	MASTER
1, 4, 8, 9, 12, 15, 18, 21	2, 5, 10, 13, 16, 19, 22	3, 6, 7, 11, 14, 17, 20

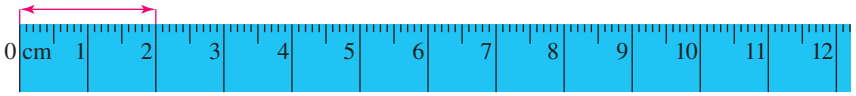
To answer questions online and to receive **immediate corrective feedback** and **fully worked solutions** for all questions, go to your learnON title at www.jacplus.com.au.

Fluency

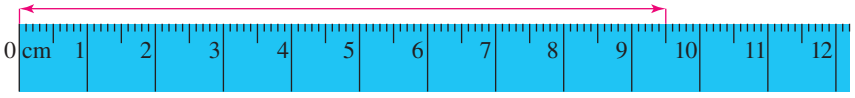
1. WE3a State the reading indicated by the arrow.

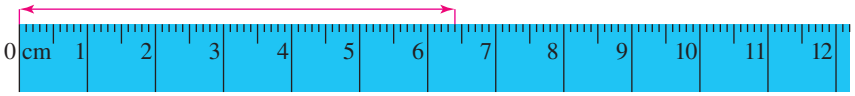
a.


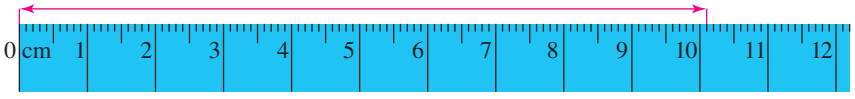
b.


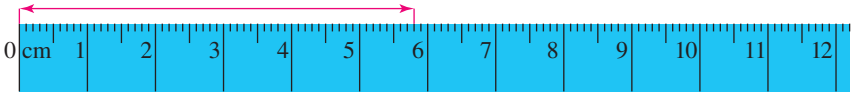
c.


2. State the reading indicated by the arrow, in decimal form.

a. WE3b


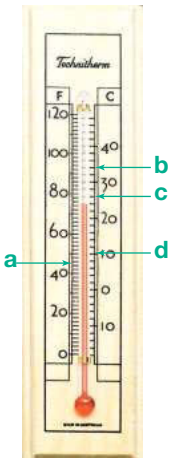
b.


c.


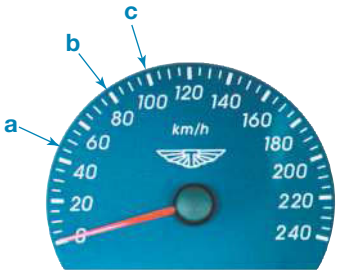
d.


3. State the reading indicated by the arrow, in decimal form.


4. State the values shown on this scale.



5. State the values shown on this scale.



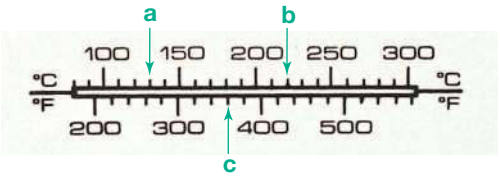
6. State the values shown in the following jugs.

a.

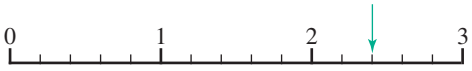
b.

7. State the value shown on this scale.

8. State the values shown on this scale.

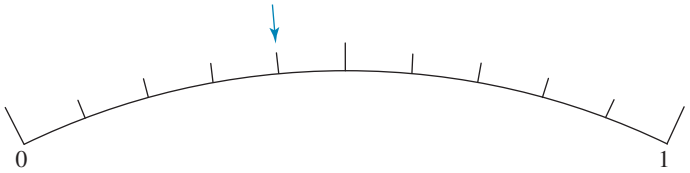


9. MC Choose the correct reading for the following scale.



A. 2.2 **B.** 2.4 **C.** 2.6 **D.** 2.8 **E.** 3.3

10. MC Choose the correct reading for the following scale.

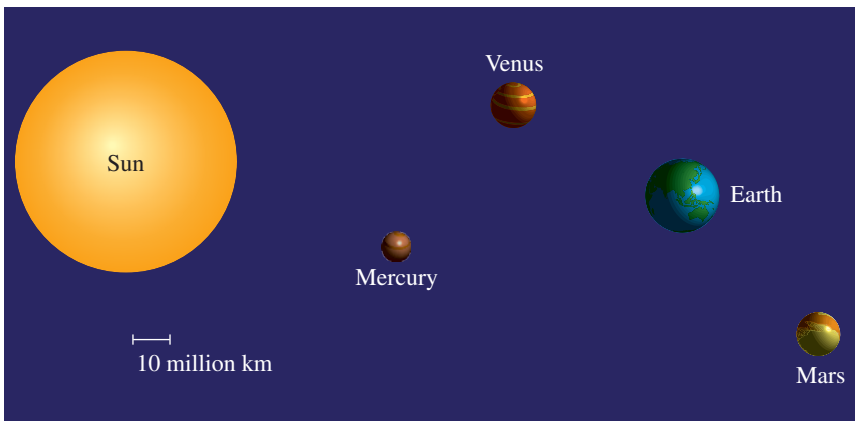


A. $\frac{4}{5}$ **B.** 4 **C.** $\frac{2}{5}$ **D.** $\frac{2}{10}$ **E.** $\frac{1}{2}$

Understanding

For questions **11** to **17**, use the given length to estimate the other length mentioned.

11. MC Approximate the distance from the centre of Earth to the centre of the Sun, using the scale bar provided.

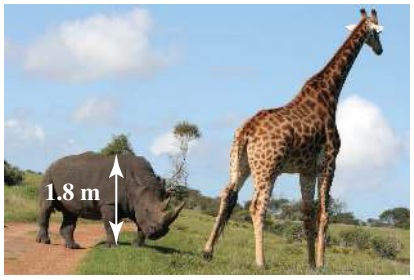


A. 10 million km **B.** 50 million km **C.** 100 million km
D. 150 million km **E.** 200 million km

12. MC If the train pictured has four carriages, identify the length of the train.

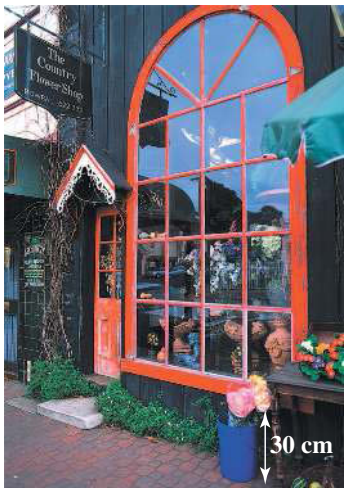
A. 15 m
B. 30 m
C. 45 m
D. 60 m
E. 150 m

13. MC If the height of the rhino in the photo is 1.8 m, choose the approximate height of the giraffe.



A. 1.8 m
B. 4.9 m
C. 3.6 m
D. 18 m
E. 7.0 m

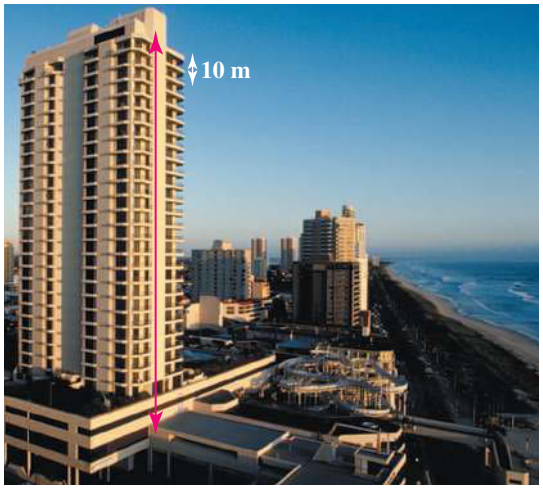
14. State the approximate height of the window (to the inside centre of the frame) if the bucket is 30 cm tall.



15. MC On the following map, select the approximate straight-line distance from Geelong to Canberra.

A. 150 km **B.** 320 km **C.** 540 km **D.** 700 km **E.** 1000 km

16. MC If 2 floors are 10 m tall, estimate the height of the building.



A. 136 m **B.** 100 m **C.** 184 m **D.** 350 m **E.** 388 m

17. MC If the orange ute is 180 cm tall, estimate the height (x) of the pole next to the building.

A. 18 m **B.** 12 m **C.** 24 m **D.** 15 m **E.** 8 m

Reasoning

18. List three examples of situations in which you would use each of the following measuring tools in everyday life.

a. A 30 cm ruler that includes millimetre markings
b. A 100 cm ruler that has only centimetre markings
c. A 2 m dressmaker's tape that includes centimetre markings
d. A 100 m measuring tape that has metre and centimetre markings

19. Use the information provided in the following photograph to estimate the height of the lamppost. Explain how you estimated this height.

20. Explain how you could use a normal ruler to determine the thickness of a page in a textbook. Estimate the thickness of a page in your Maths textbook and Science textbook.

Problem solving

21. Your friend is working on the top floor of a very tall office building. She walks up 726 steps from the ground floor to her office. Each step is 23 cm high. Calculate how high she climbs (in km), to 1 decimal place.

22. A gift box has dimensions 30 cm by 22 cm by 15 cm. If a ribbon is wrapped around this box as shown using 25 cm for a bow, determine the total length of ribbon needed.

10.4 Perimeter

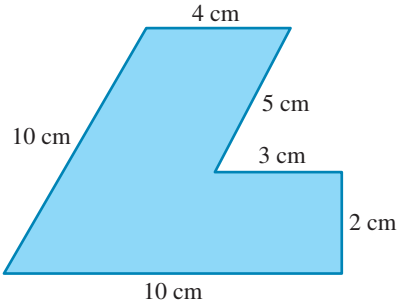
LEARNING INTENTION

At the end of this subtopic you should be able to:
- calculate the perimeter of a given shape
- calculate the perimeter of rectangles and squares.

10.4.1 Calculating the perimeter

eles-4552

- A **perimeter** is the distance around the outside (border) of a shape.
- To calculate the perimeter of the shape, convert all lengths to the same unit and then add all the lengths.

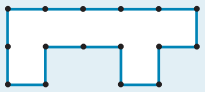


Perimeter = 4 + 5 + 3 + 2 + 10 + 10
= 34 cm

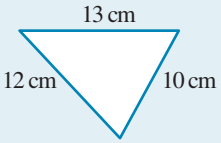
WORKED EXAMPLE 5 Calculating the perimeter of shapes

Calculate the perimeter of each shape.

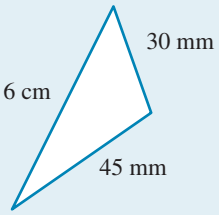
a.



b.



c.



Note: **The dots are 1 unit apart.**

THINK

a. 1. Count the number of unit intervals around the outside of the shape (16).

2. Write the answer.

b. 1. Check that the measurements are in the same unit. All are in centimetres.

2. Add the measurements to determine the perimeter.

3. Write the answer with the correct unit.

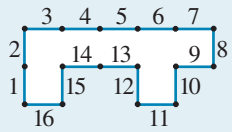
c. 1. Notice the measurements are not all the same. Convert to the smaller unit (6 cm = 60 mm).

2. Add the measurements that now have the same unit (mm) to determine the perimeter.

3. Write the answer with the correct unit.

WRITE

a.



The perimeter is 16 units.

b.

$$\begin{array}{r} 12 \\ 13 \\ +\,10 \\ \hline 35 \end{array}$$

The perimeter is 35 cm.

c. 6 cm = 60 mm

$$\begin{array}{r} 60 \\ 30 \\ +\,45 \\ \hline 135 \end{array}$$

The perimeter is 135mm.

WORKED EXAMPLE 6 Calculating perimeters of squares and rectangles

Calculate the perimeter of:

a. a rectangle that is 49.3 cm long and 22.0 cm wide

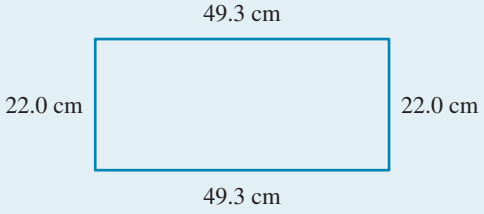
b. a square whose side length is 28 cm.

THINK

a. 1. Draw a diagram and write its measurements.

WRITE

a.



2. Check that the measurements are in the same unit. All are in centimetres. The perimeter is the distance around the rectangle, so add all the distances together.

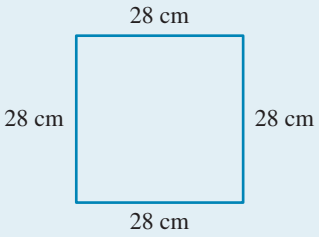
$P = 49.3 + 22.0 + 49.3 + 22.0$
$= 142.6$

3. Write the answer with the correct unit.

The perimeter is 142.6 cm.

b. 1. Draw a diagram and write its measurements.

b.



2. Check that the measurements are in the same unit. The perimeter is the distance around the square, so add all the distances together.

$P = 28 + 28 + 28 + 28$
$= 112$

3. Write the answer with the correct unit.

The perimeter is 112 cm.

DISCUSSION

What information does the perimeter give you about a shape? Is it enough to draw the shape?

eles-4553

10.4.2 Calculating the perimeter of a rectangle and a square

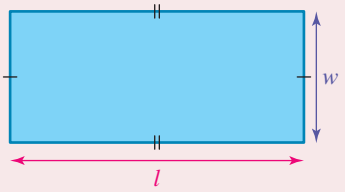
- The perimeters of rectangles and squares can be found using the following formulas.

Perimeter of a rectangle

For a rectangle, the perimeter P is:

$$P = 2(l + w)$$

where l is its length and w is its width.

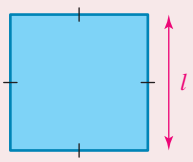


Perimeter of a square

For a square, the perimeter P is:

$$P = 4l$$

where l is its side length.



COLLABORATIVE TASK: Same perimeter, different shape

Equipment: a ball of string, A3 paper, marker pens, glue or sticky tape, ruler

1. Cut a piece of string into four equal lengths.
2. Measure and record the lengths of your pieces of string.
3. Make an enclosed shape with one of your pieces of string and stick it onto an A3 sheet of paper.
4. Write a caption about the perimeter of the shape. For example, you might write, 'It is 25 cm around this shape'.
5. Repeat steps 3 and 4 with your other pieces of string. Each time, make a different shape and write a different caption.
6. As a class, discuss the answer to the following question: What information does the perimeter give you about a shape?

Resources

eWorkbook	Topic 10 Workbook (worksheets, code puzzle and project) (ewbk-1911)
Digital document	SkillSHEET Perimeter (doc-6511)
Video eLesson	Perimeter (eles-1874)
Interactivities	Individual pathway interactivity: Perimeter (int-4357) Perimeter (int-4013) Perimeter of composite shapes (int-4014)

Exercise 10.4 Perimeter

learnON

Individual pathways

PRACTISE	CONSOLIDATE	MASTER
1, 2, 4, 7, 10, 13, 16, 19, 22	3, 5, 8, 11, 14, 17, 20, 23	6, 9, 12, 15, 18, 21, 24

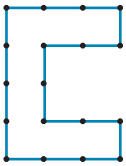
To answer questions online and to receive **immediate corrective feedback** and **fully worked solutions** for all questions, go to your learnON title at www.jacplus.com.au.

Fluency

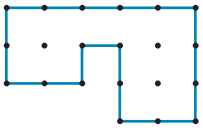
1. WE5a Calculate the perimeter of each shape. The dots are 1 unit apart.

a.

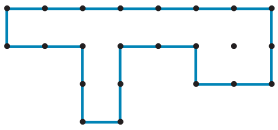
b.



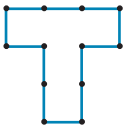
c.



d.

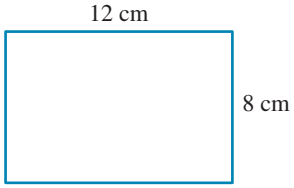


e.

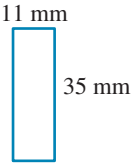


2. WE5b Calculate the perimeter of each of the following.

a.

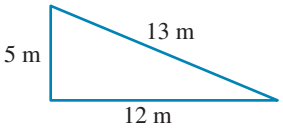


b.

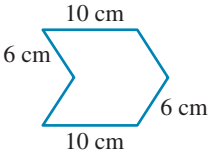


3. Calculate the perimeter of each of the following.

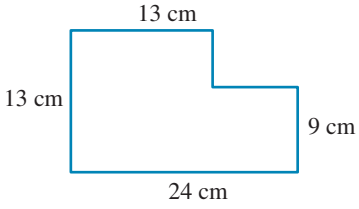
a.



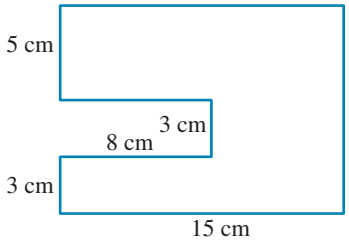
b.



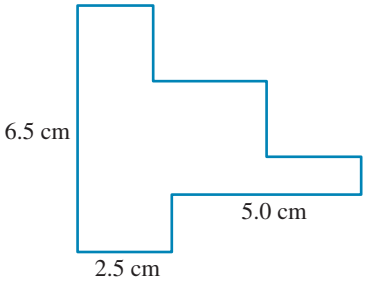
4. Calculate the perimeter of the shape shown.



5. Calculate the perimeter of the shape shown.

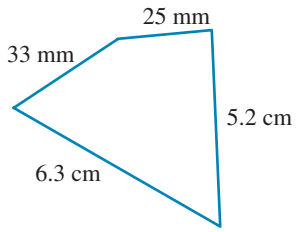


6. Calculate the perimeter of the shape shown.

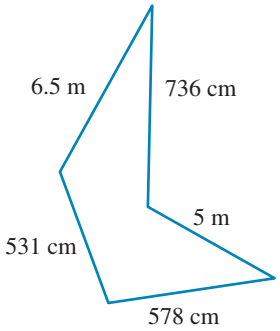


7. WE5c Calculate the perimeter of each shape, giving answers in the smaller unit in each case.

a.

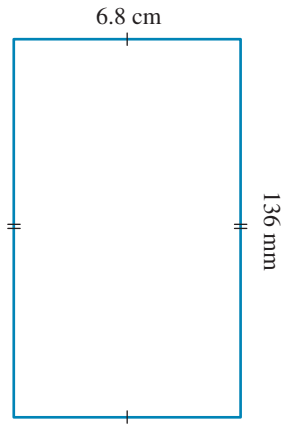


b.

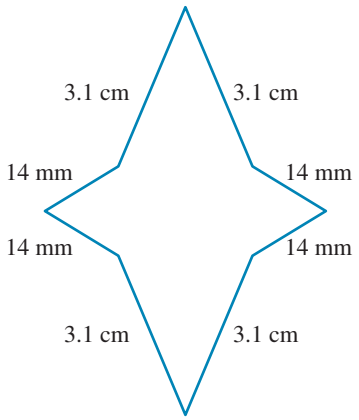


8. Calculate the perimeter of each shape, giving answers in the smaller unit in each case.

a.

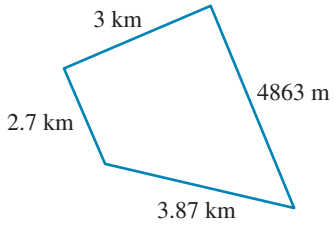


b.

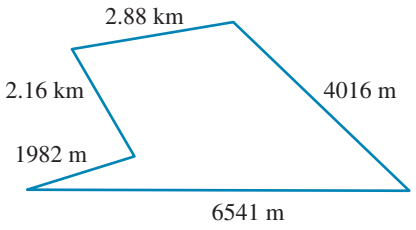


9. Calculate the perimeter of each shape, giving answers in the smaller unit in each case.

a.



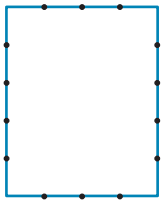
b.



10. MC Identify the perimeter of the shape shown.

A. 9 units
B. 18 units
C. 16 units
D. 14 units
E. 12 units

Note: The dots are 1 unit apart.



11. WE6

a. Calculate the perimeter of a rectangle of length 45 cm and width 33 cm.
b. Calculate the perimeter of a rectangle of length 2.8 m and width 52.1 cm.
c. Calculate the perimeter of a square of side length 3.7 cm.

12. a. Calculate the perimeter of a rectangle of length $4\frac{1}{4}$ m and width $2\frac{1}{5}$ m.

b. Calculate the perimeter of a square of side length $8\frac{1}{5}$ mm.

Understanding

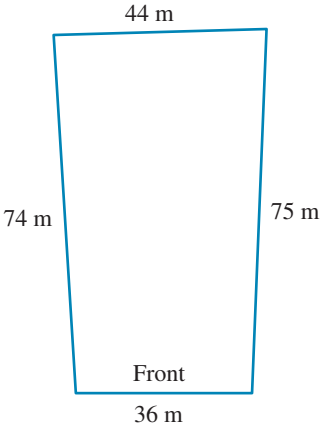
13. Calculate the length of party lights needed to decorate the perimeter of a rectangular tent with dimensions 15.5 m by 8.75 m.

14. Allowing an extra 30 cm for waste, calculate the length of picture frame required to frame the artwork shown in the photo.

15. Zedken wishes to install three strands of barbed wire at the top of the fences around a rectangular work site. The length of the site is 34.5 m, and its width is 19.8 m. Calculate the length of wire needed.

16. A new game, Bop-ball, is played on a triangular field, where each side of the triangle measures 46.6 m. A greenkeeper is marking the field's perimeter using a chalk-dispensing trundle wheel. Determine how far the greenkeeper will walk to mark the field.

17. Phang's property boundary dimensions are shown in the diagram.



- **a.** Calculate how many metres of fencing are needed to fence all but the front boundary.
- **b.** If the fencing costs $19 per metre, calculate the total cost.

18. Lucille has received a quote of $37 per metre for new fencing for a tennis court. The tennis court is 23.77 m long and 10.97 m wide. There should be a 3.6 m space between each side of the court and the fence, and a 6.4 m gap between each end of the court and the fence.

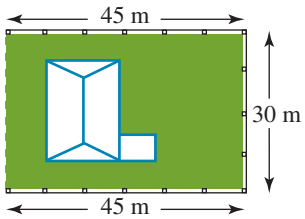
- **a.** Draw a diagram showing all given measurements.
- **b.** Determine how many metres of fencing are needed.
- **c.** Based on the quote, calculate the total cost of the fencing.

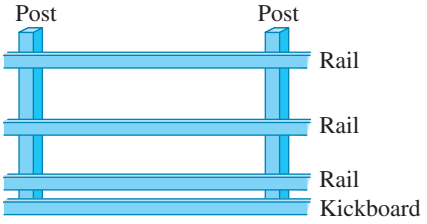
Reasoning

19. Suggest a type of work where people need to calculate perimeters on a daily basis.

20. A piece of paper is 22 cm long, including a 2.2 cm sticky strip at each end. Five strips of paper are stuck together so that the sticky parts overlap exactly to make a loop of paper. Determine the circumference of (distance around) the loop.

21. Marc and Cathy are seeking quotes for the cost of building a fence on three sides of their property. They want to calculate approximate costs for each item to decide whether the quotes supplied sound reasonable.





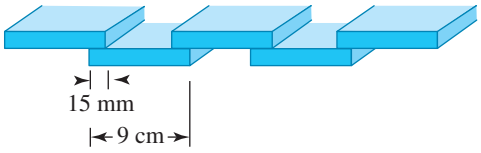
The new fence requires three rails, a kickboard, posts and palings.

- **a.** Calculate the length of timber needed for the kickboard.
- **b.** Calculate the cost of the kickboard if the timber required for this costs $1.90 per metre.
- **c.** If the timber for the rails costs $2.25 per metre, determine the total cost of the timber for the railings.

d. Determine how many posts will be needed for the new fence if each post is to be 5 metres apart and there needs to be a post at the end of each straight section of fence.

e. Calculate the cost of the posts if the price of each post is $13.65.

Palings are 9 cm wide and are nailed so they overlap each other by 15 mm on each side.



f. i. Calculate the approximate number of palings needed for the fence.

ii. Palings cost $1.05 each. Determine how much money should be allowed for the total cost of the palings.

g. Write an itemised list of all the costs involved. Include an amount to cover labour charges and miscellaneous items like the cost of nails. This amount is around $1000 (two people for two days at approximately $30.00 per hour for an eight-hour day). Estimate the cost of the new fence. This will provide Marc and Cathy with information to use when comparing builders' quotes.

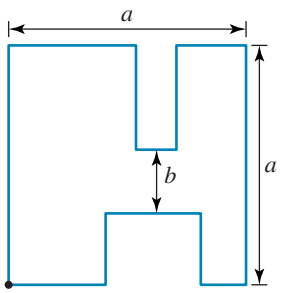
Problem solving

22. Kelly has a piece of string 32 cm long. He uses it to form rectangular shapes that each have a length and a width that are a whole number of centimetres.

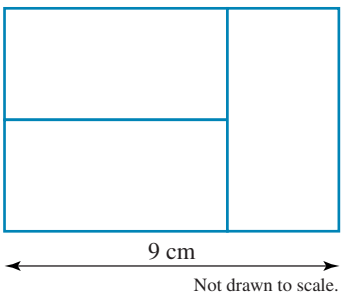
a. Identify how many different rectangular shapes he can form.

b. Predict what the sides of the rectangle will be to give the largest possible area. Check by drawing different rectangles to see if your prediction is correct.

23. Write an equation for the perimeter of the diagram shown in terms of a and b.



24. The rectangle shown is made up of three identical, smaller rectangles that fit inside (as shown). If its length measures 9 cm, work out its width without using a ruler.



10.5 Area

LEARNING INTENTION

At the end of this subtopic you should be able to:

- calculate, or estimate, the area of a given shape
- calculate the area of rectangles, squares, triangles and parallelograms using formulas.

10.5.1 Metric units of area

eles-4554

- The **area** of a shape is the amount of flat surface enclosed by the shape.
- Area is measured in square units such as square centimetres, square metres and square kilometres.
- Commonly used metric units of area, with their abbreviations and examples, are shown in the following figures.

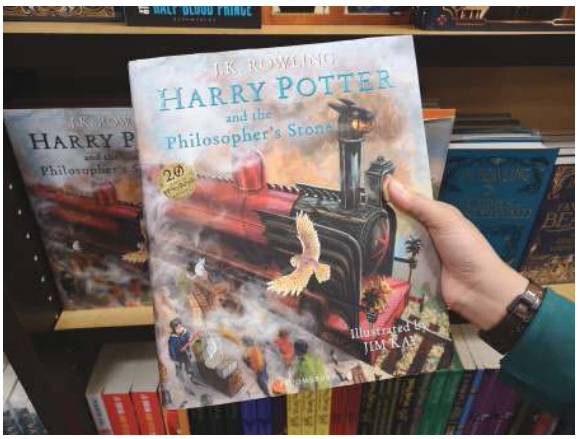
1. Square kilometres (km^2)

The area of a country or a large city like Sydney is given in square kilometres.

2. Square metres (m^2)

Square metres are used to measure the area of an object such as a classroom floor, whiteboard or a window.

3. Square centimetres (cm^2)

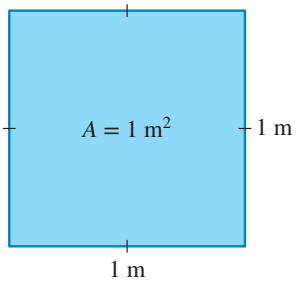


Small areas, such as the area of a sheet of A4 paper or a book cover, are measured in square centimetres.

4. Square millimetres (mm^2)

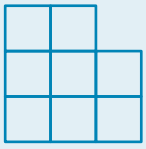
Very small areas, such as the area of a button or a postage stamp, are measured in square millimetres.

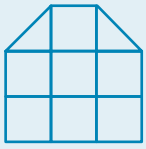
- The area of a farm or a large city park is measured in hectares (ha). $1\text{ ha} = 10\,000\text{ m}^2$.
- 1 square metre is the area enclosed by a square with sides that are 1 m long. The same is true for any other unit.
- If a shape is drawn on 1 cm grid paper, its area can be found by counting the number of squares that the shape covers.



WORKED EXAMPLE 7 Determining area by counting squares

The following figures are drawn on centimetre grid paper. Determine the area of each one.

a. 

b. 

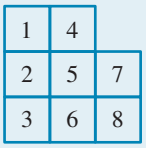
THINK

a. Count the squares. Remember to include the correct unit (cm^2) in the answer.

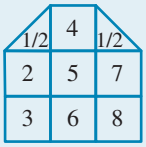
b. Some of the squares are cut in half by the diagonal line. It takes two of these to make up one square centimetre. Count the squares. Remember to include the correct unit (cm^2) in the answer.

WRITE

a. 8 cm^2



b. 8 cm^2



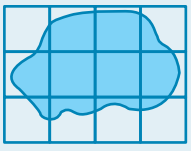
Estimating shaded areas

If a square of the grid paper is not completely covered by the shape, use the following rule to obtain an estimate of the area.

- If more than half the square is covered, count it as a full square.
- If less than half the square is covered, do not count it at all.

WORKED EXAMPLE 8 Estimating the shaded area

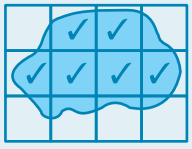
Estimate the shaded area of the following diagram drawn on centimetre grid paper.



THINK

1. Tick the squares that are more than half covered and count them.
2. State the answer, with the correct unit.

WRITE



6 cm^2

10.5.2 Calculating the area of a rectangle

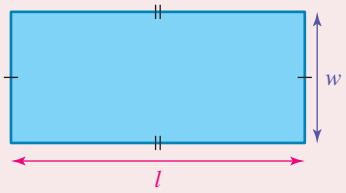
eles-4555

- The areas of rectangles and squares can also be calculated by using the following formulas.

Area of a rectangle

For a rectangle, the area A is:

$$A = l \times w$$
$$= lw$$

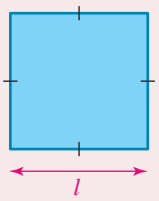


where l is the length and w is the width of the rectangle.

Area of a square

For a square, the area A is:

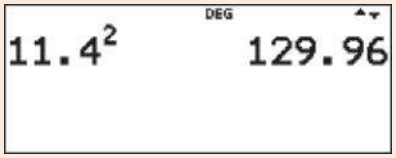
$$A = l \times l$$
$$= l^2$$



where l is the length of the square's side.

Digital technology

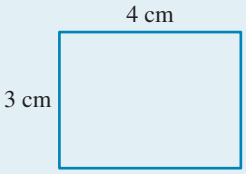
A quick way to calculate the area of a square on a calculator is to use the 'square' button. The button has the symbol x^2 and will square the number that you type in.



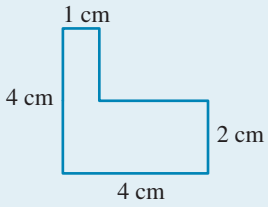
WORKED EXAMPLE 9 Calculating areas of different shapes

Calculate the areas of the following shapes.

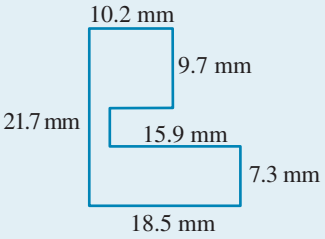
a.



b.



c.

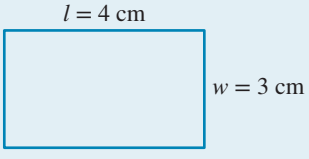


THINK

a. 1. Write the formula for the area of a rectangle.

WRITE

a. $A = lw$



2. Substitute the value 4 for l and 3 for w and calculate the area.

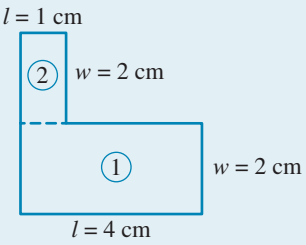
$A = 4 \times 3$
$= 12 \text{ cm}^2$

3. State the answer in the correct unit (cm^2).

The area is $12\ cm^2$.

b. 1. Divide the shape into two rectangles.

b.



2. Calculate the area of each rectangle separately by substituting the correct values of l and w into the formula $A = lw$.

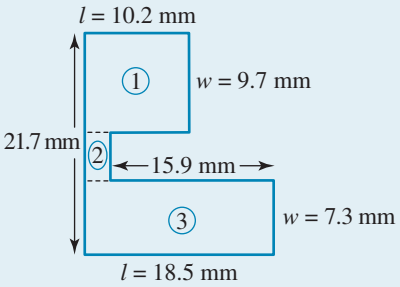
$$\text{Area of rectangle 1} = l \times w$$
$$= 4 \times 2$$
$$= 8\ cm^2$$
$$\text{Area of rectangle 2} = l \times w$$
$$= 1 \times 2$$
$$= 2\ cm^2$$

3. Add the two areas. Remember to answer in the correct unit (cm^2).

$$\text{Area of shape} = \text{Area of rectangle 1} + \text{Area of rectangle 2}$$
$$= 8\ cm^2 + 2\ cm^2$$
$$= 10\ cm^2$$

c. 1. Divide the shape into three rectangles.

c.



2. Calculate the area of each rectangle separately by substituting the correct values of l and w into the formula $A = lw$.

$$\text{Area of rectangle 1} = l \times w$$
$$= 10.2 \times 9.7$$
$$= 98.94\ mm^2$$
$$\text{Area of rectangle 2} = l \times w$$
$$= (21.7 - 9.7 - 7.3) \times (18.5 - 15.9)$$
$$= 4.7 \times 2.6$$
$$= 12.22\ mm^2$$
$$\text{Area of rectangle 3} = l \times w$$
$$= 18.5 \times 7.3$$
$$= 135.05\ mm^2$$

3. Add the three areas. Remember to answer in the correct unit (mm^2).

$$\text{Area of shape} = \text{Area 1} + \text{Area 2} + \text{Area 3}$$
$$= 98.94\ mm^2 + 12.22\ mm^2 + 135.05\ mm^2$$
$$= 246.21\ mm^2$$

COLLABORATIVE TASK: Rectangles with the same areas and perimeters

Work in pairs to answer the following questions.

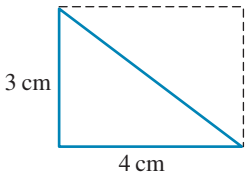
Compare the perimeters of two different rectangles, each with an area of 60 cm^2. Which rectangles have the smallest perimeters and which have the largest perimeters?

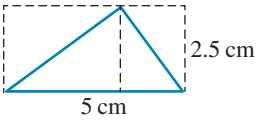
Compare the areas of different rectangles, each with a perimeter of 24 cm. Which rectangles have the smallest areas and which have the largest areas?

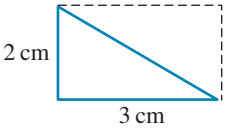
10.5.3 Calculating the area of a triangle

eles-4556

- Triangles can be formed by cutting rectangles in half.





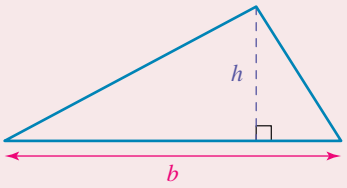


- The area of a triangle is therefore equal to half the area of a rectangle of the same base length and height.

Area of a triangle

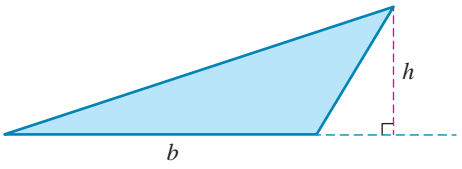
To calculate the area A of a triangle:

$$A = \frac{1}{2}b \times h$$
$$= \frac{1}{2}bh$$



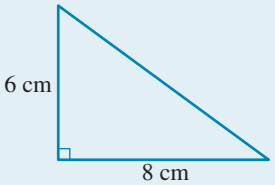
where b is the base and h the perpendicular height.

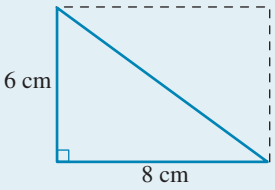
- To measure the perpendicular height of a triangle, the line must form a right angle with the base of the triangle. Sometimes this line will have to be drown outside the triangle, as shown in the following diagram.



WORKED EXAMPLE 10 Calculating the area of a right-angled triangle

Calculate the area of the following shape.

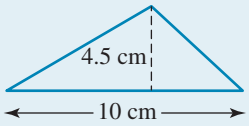


THINK	WRITE
Method 1: Using the formula for the area of a triangle	
1. Write the formula for the area of a triangle.	$A = \frac{1}{2}bh$
2. Identify the values of b and h.	$b = 8\text{ cm}, h = 6\text{ cm}$
3. Substitute the values of b and h into the formula.	$A = \frac{1}{2} \times 8 \times 6$
4. Evaluate. (Since one of the values is even, halve it first to make calculations easier.) Remember to include the correct unit (cm^2).	$= 4 \times 6$ $= 24\text{ cm}^2$
Method 2: By cutting the rectangle in half	
1. Draw an imaginary rectangle that contains the triangle. The rectangle should have the same base length and height as the triangle. Notice that the triangle forms half of the rectangle.	
2. Use the formula $A = lw$ to calculate the area of this rectangle.	$A = lw$ $= 8\text{ cm} \times 6\text{ cm}$ $= 48\text{ cm}^2$
3. Halve the area of the rectangle to get the area of the triangle. Remember to answer in the correct unit (cm^2).	Area of triangle $= \frac{1}{2}$ of area of rectangle Area of triangle $= \frac{1}{2} \times 48$ $= 24\text{ cm}^2$

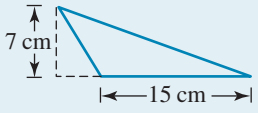
WORKED EXAMPLE 11 Calculating the area of a triangle

Calculate the area of each of these triangles.

a.



b.



THINK	WRITE
a. 1. Write the formula for the area of a triangle.	**a.** $A = \frac{1}{2}bh$
2. Identify the values of b and h.	$b = 10, h = 4.5$
3. Substitute the values of b and h into the formula.	$A = \frac{1}{2} \times 10 \times 4.5$
4. Evaluate. (Since one of the values is even, halve it first to make calculations easier.) Remember to include the correct unit (cm^2).	$= 5 \times 4.5$ $= 22.5\text{ cm}^2$

b. **1.** Write the formula for the area of a triangle.

b. $A = \frac{1}{2}bh$

2. Identify the values of b and h.

$b = 15, h = 7$

3. Substitute the values of b and h into the formula.

$A = \frac{1}{2} \times 15 \times 7$

4. Evaluate. (Since neither value is even, multiply 15 and 7 first, and then divide by 2.) Remember to include the correct unit (cm^2).

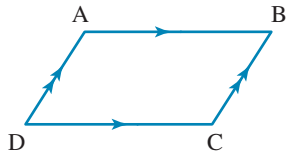
$= \frac{1}{2} \times 105$

$= 52.5\ cm^2$

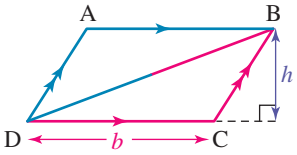
10.5.4 Area of a parallelogram

eles-4557

- A **parallelogram** is a quadrilateral having each pair of opposite sides parallel.



- To calculate the area of the parallelogram, first draw a diagonal from B to D to form two triangles, ABD and BDC. Label the base b and the perpendicular height h.



- The area of triangle BCD $= \frac{1}{2}b \times h$ and the area of triangle ABD $= \frac{1}{2}b \times h$.
  So, the area of the parallelogram:

$$\begin{aligned} \text{ABCD} &= \frac{1}{2}b \times h + \frac{1}{2}b \times h \\ &= b \times h \end{aligned}$$

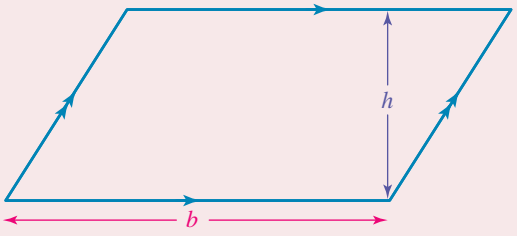
where b is the base and h is the perpendicular height.

Area of a parallelogram

The area of a parallelogram is:

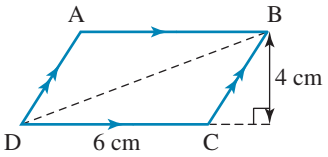
$$\boldsymbol{A = bh}$$

where b is the base and h is the perpendicular height.



- For example, the area of the parallelogram shown is:

$$\begin{aligned} \text{ABCD} &= b \times h \\ &= 6 \times 4 \\ &= 24 \text{ cm}^2 \end{aligned}$$



on Resources

eWorkbook	Topic 10 Workbook (worksheets, code puzzle and project) (ewbk-1911)
Digital documents	SkillSHEET Area units (doc-6512) SkillSHEET Area of figures drawn on one-centimetre grid paper (doc-6513) SkillSHEET Area of rectangles (doc-6514) SkillSHEET Area of triangles (doc-6515)
Interactivities	Individual pathway interactivity: Area (int-4358) Metric units of area 1 (int-4015) Metric units of area 2 (int-4016) Area of a rectangle (int-4017) Area of a triangle (int-4018) Area of a parallelogram (int-4019)

Exercise 10.5 Area

learnON

Individual pathways

PRACTISE	CONSOLIDATE	MASTER
1, 4, 5, 8, 9, 13, 14, 18, 21, 24, 26, 29, 31	2, 6, 10, 11, 15, 17, 19, 22, 25, 27, 30, 32, 34, 35	3, 7, 12, 16, 20, 23, 28, 33, 36, 37

To answer questions online and to receive **immediate corrective feedback** and **fully worked solutions** for all questions, go to your learnON title at www.jacplus.com.au.

Fluency

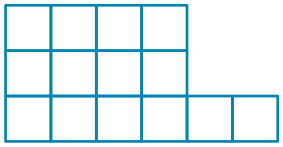
1. Identify which unit would be most suitable to measure the following areas. Choose from mm^2, cm^2, m^2, ha or km^2.

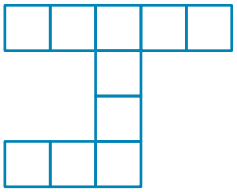
a. A computer screen
b. The Melbourne Cricket Ground
c. A shirt button
d. The Brisbane metropolitan area

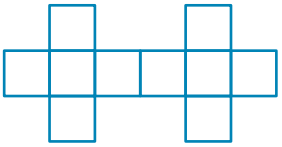
2. Identify which unit would be most suitable to measure the following areas. Choose from mm^2, cm^2, m^2, ha or km^2.

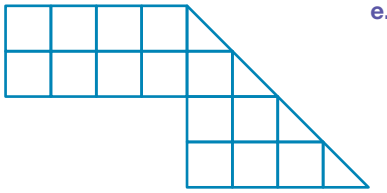
a. A house block
b. The state of Queensland
c. A basketball court
d. A dairy farm

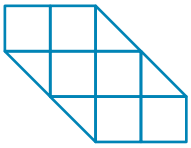
3. WE7a The following figures are drawn on centimetre grid paper. Determine the area of each one.

a. 

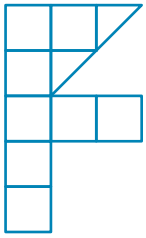
b. 

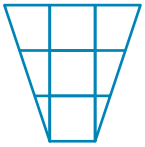
c. 

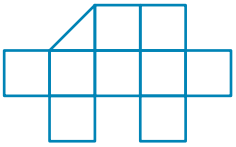
d. 

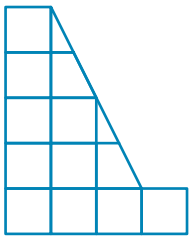
e. 

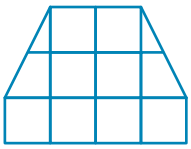
4. Estimate the areas of the following figures, which are drawn on centimetre grid paper.

a. 

b. 

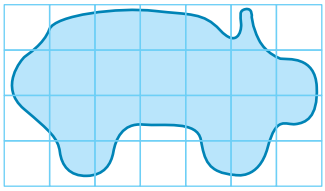
c. 

d. 

e. 

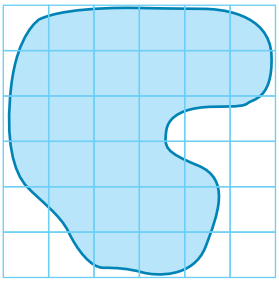
5. MC Select from the following an estimate for the area of the shape drawn on centimetre grid paper.

A. 18 cm^2
B. 21 cm^2
C. 16 cm^2
D. 23 cm^2
E. 28 cm^2



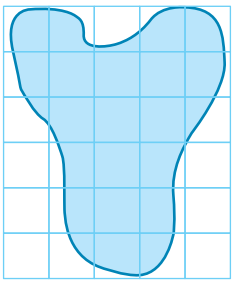
6. MC Select from the following an estimate for the area of the shape drawn on centimetre grid paper.

A. 16 cm^2
B. 20 cm^2
C. 25 cm^2
D. 28 cm^2
E. 30 cm^2



7. MC Select from the following an estimate for the area of the shape drawn on centimetre grid paper.

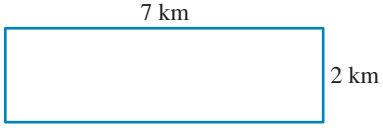
A. 15 cm^2
B. 17 cm^2
C. 19 cm^2
D. 21 cm^2
E. 25 cm^2



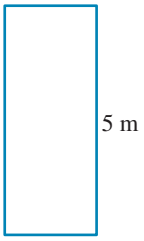
8. WE9a Determine the areas of the following rectangles. (*Hint:* Use the formula $A = lw$.)

a.

b.

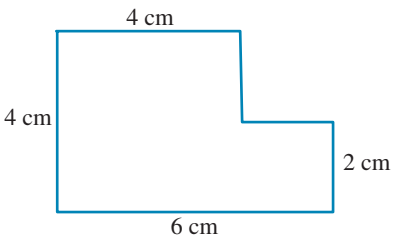


c.

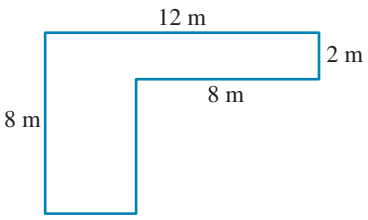


WE9b, c For questions **9** to **12**, calculate the areas of the following shapes. (*Hint:* Divide the shapes into rectangles and squares before using the formula $A = lw$)

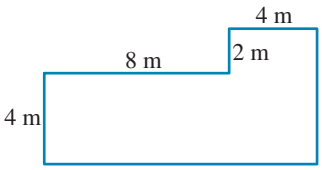
9. a.



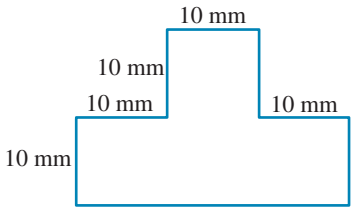
b.



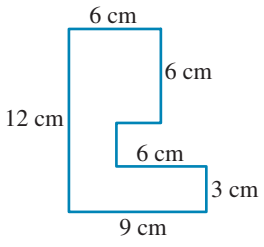
10. a.



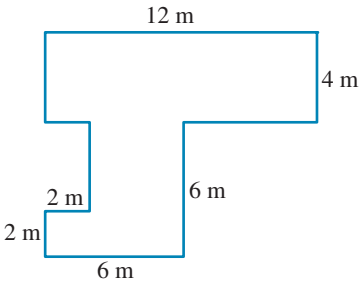
b.



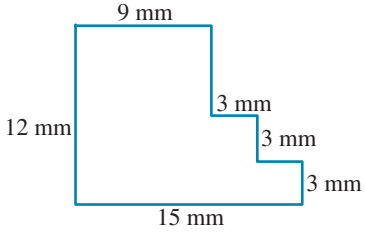
11. a.



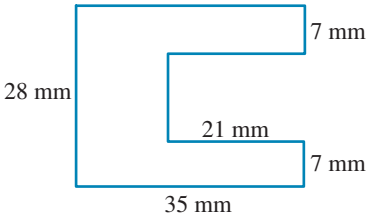
b.



12. a.

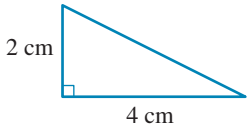


b.

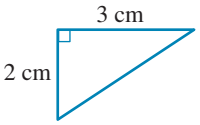


13. WE10 Calculate the areas of the following triangles.

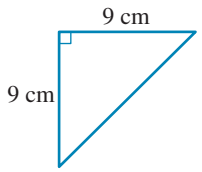
a.



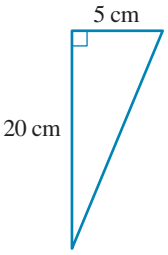
b.



c.

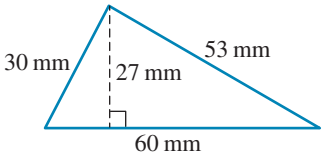


d.



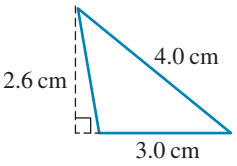
14. MC Identify the height of the triangle shown.

A. 60 mm **B.** 30 mm **C.** 27 mm
D. 53 mm **E.** 49 mm



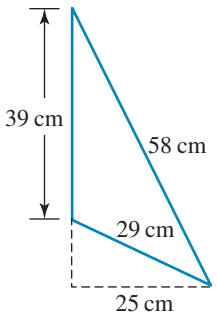
15. MC Identify the height of the triangle shown.

A. 2.6 cm **B.** 4.0 cm **C.** 3.0 cm
D. 4.2 cm **E.** 3.8 cm



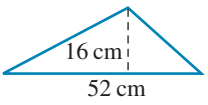
16. MC Identify the base length of the triangle shown.

A. 39 cm **B.** 58 cm **C.** 29 cm
D. 25 cm **E.** 43 cm

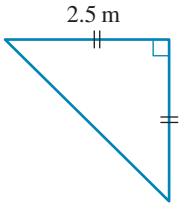


17. WE11 Calculate the area of each of these triangles.

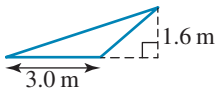
a.



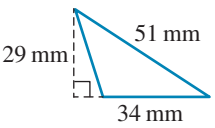
b.



c.

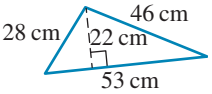


d.

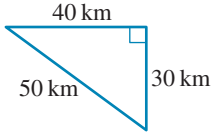


18. Calculate the area of each of these triangles.

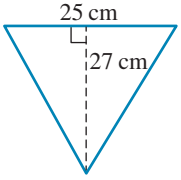
a.



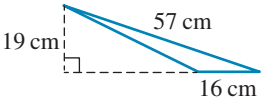
b.



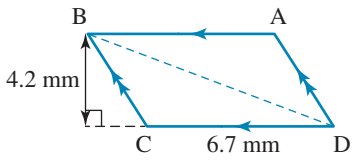
c.



d.

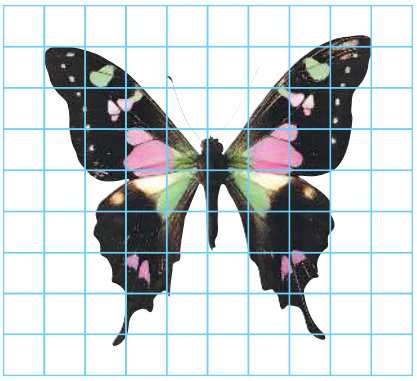


19. Calculate the area of the following parallelogram.



Understanding

20. MC Select the closest estimate of the area of this butterfly if a centimetre grid is placed over it as shown.



A. 10 cm^2
B. 18 cm^2
C. 27 cm^2
D. 38 cm^2
E. 51 cm^2

21. One of the largest open-air shopping centres is the Ala Moana centre in Honolulu, Hawaii, USA with more than 200 shops covering an area of 20 hectares. Convert this area to square metres.

22. The Taupo volcanic eruption that occurred in New Zealand nearly 2000 years ago is estimated to have flattened an area of 16 000 km^2.

a. Convert this area to square metres.
b. Convert this area to hectares.

23. Calculate how many square metres of carpet are needed to cover a rectangular room of length 5 m and width 3.5 m.

24. Determine the area of material needed to make a rectangular rug that is 4.2 m long and 230 cm wide. (Give your answer in square metres.) (*Hint:* Convert the width measurement into metres first.)

25. Toby is tiling his bathroom with ceramic tiles that cost $35.20 per box.

a. Calculate how many square metres of tiles he will need if the rectangular room has a width of 2.5 m and a length of 3 m.
b. Calculate how many boxes of tiles he should order if each box contains enough tiles to cover 0.5 m^2.
c. Determine the cost of the tiles.

Reasoning

26. Alana, who works for Fast Glass Replacements, has been asked for a quote to replace three windows. Each window is 1.8 m long and 0.8 m wide. Determine the price Alana should quote if the glass costs $27 per square metre. (Include a delivery cost of $25 in the quote.)

27. A floor tiler charged $640.00 to tile a rectangular room. Her next job is to tile the floor of a rectangular room twice as long and twice as wide. Determine how much she should charge for the larger room. (The answer is not $1280.00.) Justify your answer.

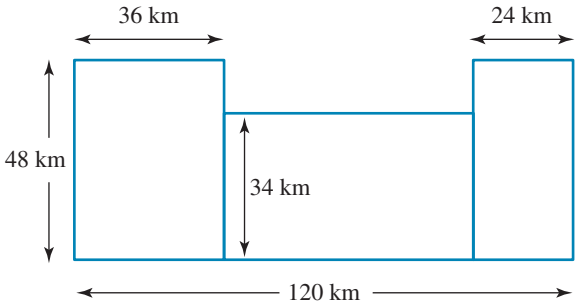
28. Glen wants to pave his back courtyard. His courtyard is 12 m × 12 m. He has a choice of 10 cm × 25 cm clay pavers that cost $2.30 each, or concrete pavers that are 70 cm × 70 cm and cost $42 each. Compare the costs of each to determine the cheaper option.

Problem solving

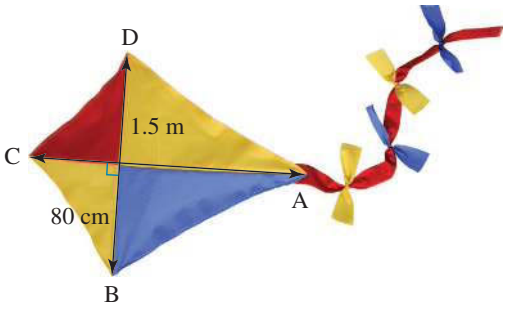
29. For the sailboat shown, calculate the approximate area of the triangular mainsail when the sail is flat. Use the dimensions shown.

30. Jane is a landscape gardener who is laying a new lawn. The rectangular lawn is 13 m long and 8 m wide. Calculate how many square metres of turf Jane should order.
Calculate the total cost of the turf if it costs $12.50 per square metre.

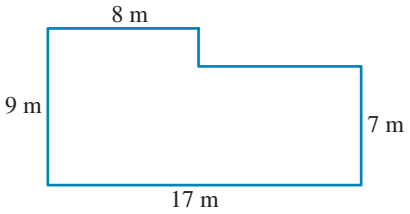
31. Calculate the total area of the cattle station shown in the diagram, which has 3 large paddocks. (Give your answer in square kilometres.)



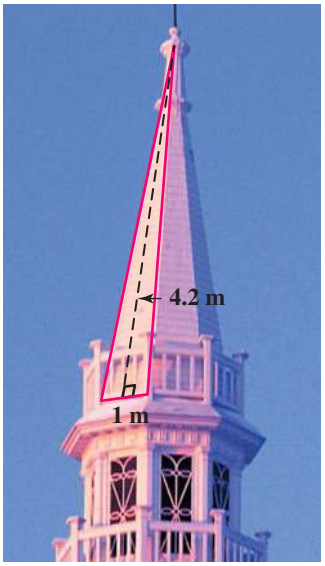
32. Determine the area of cloth required to make the kite shown, given that the length BD is 80 cm and the length AC is 1.5 m.



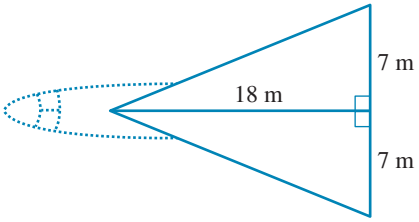
33. Calculate the total floor area of a concrete slab for a house as shown in the following diagram.



34. A church spire has six identical triangular faces that have the dimensions shown. Determine the area of copper roofing required to cover all six faces of the spire.



35. Calculate the total wing area of the following delta-winged jet aircraft.



36. A rectangle has an area of 36 cm^2 and a perimeter of 26 cm. Each side of the rectangle is a whole number of centimetres. Determine the length and width of this rectangle. Show your working.

37. Geoff wants to establish a rectangular vegetable garden bed on his farm. His work shed is 20 m long, and it will act as one of the boundaries for the garden bed. (*Note:* The garden will not necessarily be this long.) He has 24 metres of fencing, which he plans to use to fence the other three sides. Describe how Geoff could use this fencing to enclose the largest possible area.

10.6 Area of composite shapes

LEARNING INTENTION

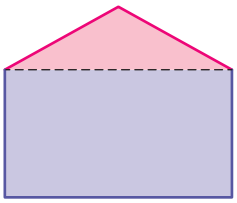
At the end of this subtopic you should be able to:

- separate composite shapes into simple shapes
- calculate the areas of composite shapes by adding or subtracting areas of simple shapes.

10.6.1 Calculating the area of composite shapes

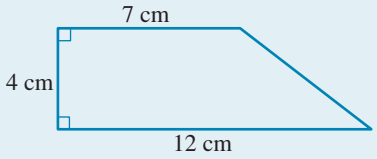
eles-4558

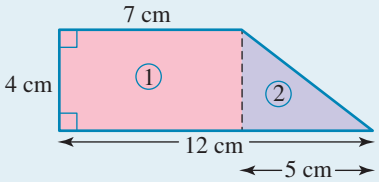
- **Composite shapes** can be separated into parts, each of which is a simple shape (such as, for example, a rectangle or a triangle).
- The area of a composite shape can be found by adding the areas of each of the separate parts.
- For example, the area of the following pentagon can be found by adding the areas of the triangle and rectangle.



WORKED EXAMPLE 12 Calculating the area of a composite shape using addition

Calculate the area of the following shape.

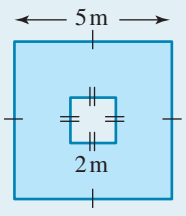


THINK	WRITE
1. Divide the shape into a rectangle and a triangle.	
2. Calculate the area of shape 1 using the formula $A = lw$. The value of $l = 7$ cm and $w = 4$ cm.	Area 1 $= lw$ $\quad l = 7$ cm, $w = 4$ cm
3. Substitute the values of l and w in the formula to calculate the area of the rectangle.	$= 7 \times 4$ $= 28\ \text{cm}^2$
4. Calculate the area of shape 2 using the formula $A = \frac{1}{2}bh$. The value of $b = 5$ cm and $h = 4$ cm.	Area 2 $= \frac{1}{2}bh$ $\quad b = 5$ cm, $h = 4$ cm
5. Substitute the values of b and h in the formula to calculate the area of the triangle.	$= \frac{1}{2} \times 5 \times 4$ $= 10\ \text{cm}^2$
6. Add the two areas to get the total area.	Total area $= A_1 + A_2$ $= 28 + 10$ $= 38\ \text{cm}^2$
7. Write the answer with the correct units.	The area of the composite shape is $38\ \text{cm}^2$.

- In many situations the area of a given shape can be found by subtracting individual areas from each other.

WORKED EXAMPLE 13 Calculating the area of a composite shape using subtraction

Calculate the shaded area in the following figure.



THINK	WRITE
1. The figure shows a large square with the blue shaded area and a small square.	Area of a square $= l^2$
2. Calculate the area of the large square.	Area of the large square: $A = 5^2$ $= 5 \times 5$ $= 25\ \text{m}^2$
3. Calculate the area of the small square.	Area of the small square: $A = 2^2$ $= 2 \times 2$ $= 4\ \text{m}^2$
4. To calculate the area of the shaded region, subtract the area of the small square from that of the large one.	Shaded area $= 25 - 4$ $= 21\ \text{m}^2$
5. Write the answer with the correct unit.	The shaded area is $21\ \text{m}^2$.

Resources

- **eWorkbook** Topic 10 Workbook (worksheets, code puzzle and project) (ewbk-1911)
- **Video eLesson** Composite area (eles-1886)
- **Interactivities** Individual pathway interactivity: Area of composite shapes, using addition and subtraction (int-4359)
  Area of composite shapes (int-4020)

Exercise 10.6 Area of composite shapes

learnON

Individual pathways

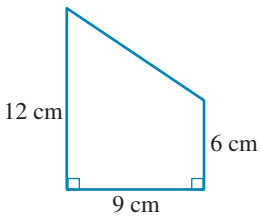
PRACTISE	CONSOLIDATE	MASTER
1, 5, 7, 9, 11, 14	2, 6, 10, 12, 15	3, 4, 8, 13, 16

To answer questions online and to receive **immediate corrective feedback** and **fully worked solutions** for all questions, go to your learnON title at www.jacplus.com.au.

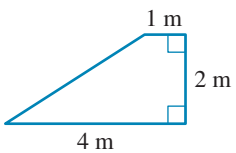
Fluency

1. WE12 Calculate the area of the following composite shapes.

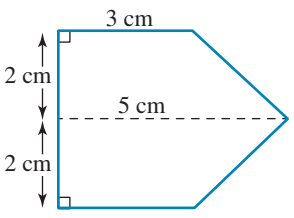
a.



b.

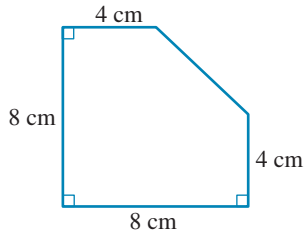


c.

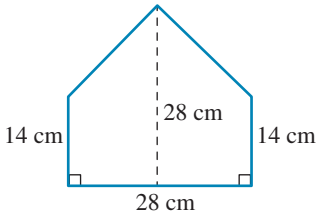


2. Calculate the area of the following composite shapes.

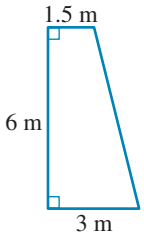
a.



b.

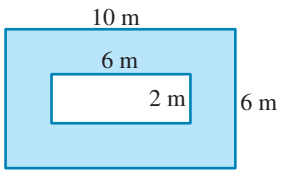


c.

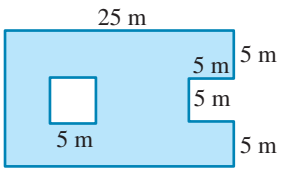


3. **WE13** Calculate the shaded area of the following shapes.

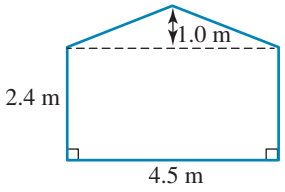
a.



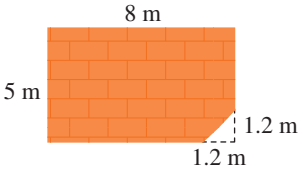
b.



4. Calculate the area of the following garage wall.

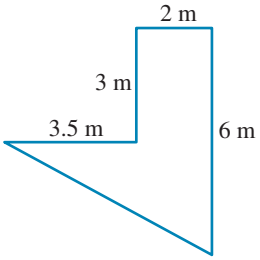


5. Determine the area of bricks needed to cover the following courtyard.



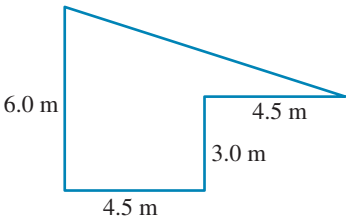
Understanding

6. Determine the area of the hotel lobby in the following diagram.



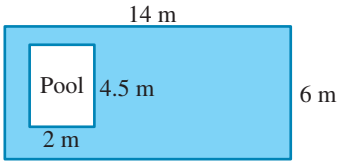
7. **a.** Calculate the area of carpet needed for the floor plan shown.

b. Determine the cost of carpeting the room if the carpet costs $25 per square metre.

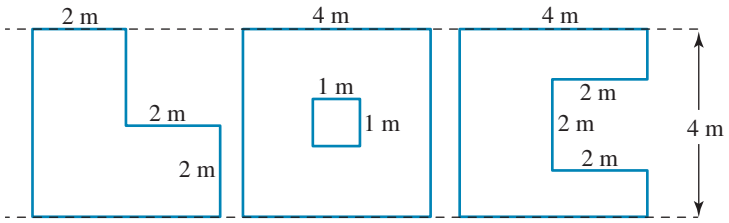


8. Michael is paving a rectangular yard that is 15.5 m long and 8.7 m wide. A square fishpond with side lengths of 3.4 m is in the centre of the yard. Calculate the cost of paving Michael's yard if the paving material costs $17.50 per square metre.

9. Members of the Lee family want to pave the area around their new swimming pool. The pool is set into the corner of the yard as shown in the diagram. Calculate the area of paving (in square metres) required to cover the yard around the pool (shaded in the diagram).

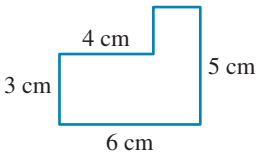


10. In order to construct an advertising sign, the following letters are cut from plastic sheets. Calculate the total area of plastic required to make all 3 letters.



Reasoning

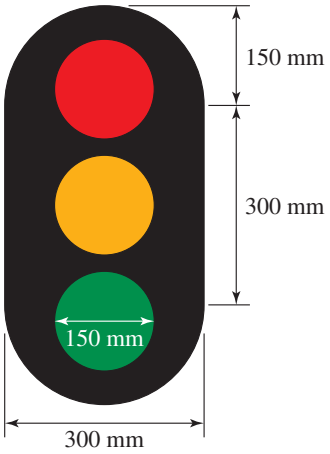
11. **a.** Calculate the area of the diagram. Show all your working.
b. Calculate the area of the figure using an alternative method. Show all your working.
c. Explain the differences between the two methods.



12. When determining the area of a composite shape, explain how you would decide whether to use addition or subtraction.

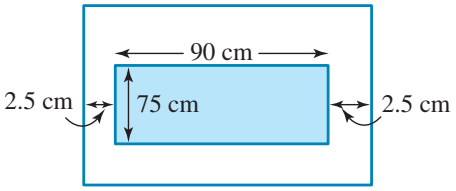
13. The stylised diagram of a set of traffic lights has been constructed using basic shapes, as shown.

a. State the shapes used to draw the diagram and their dimensions in cm.
b. Explain the steps required in calculating the black area surrounding the traffic lights shown.
c. If the area of one of the large semicircles is closest to 353 cm^2, and the area of one of the small coloured circles is closest to 177 cm^2, calculate the area of the black surface. State the answer in cm^2.
d. Explain why it is more appropriate to express the area in cm^2 rather than mm^2.

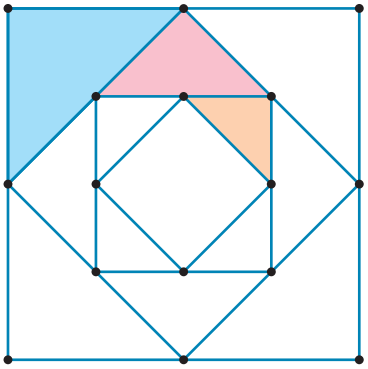


Problem solving

14. Ellen wants to frame her cross-stitch work. Her cross-stitch work is 90 cm long and 75 cm wide. The frame's border, shown in the diagram, measures 2.5 cm wide. One company charges $120 for the frame. Determine the cost of the frame per square centimetre. Round your answer to 2 decimal places.



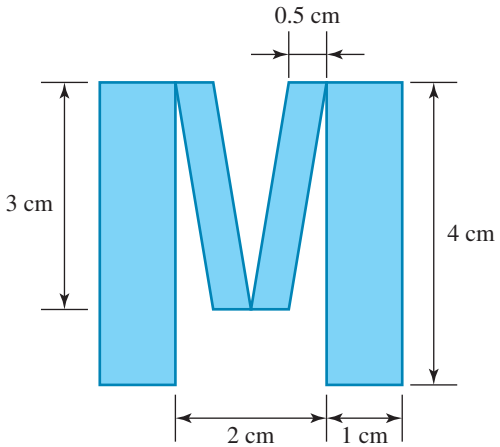
15. A square of side length 1 metre is made up of smaller internal squares that are formed by joining the midpoints of the outer square as shown in the diagram. Determine how much of the square the shaded area represents.



16. The diagram of the letter M shown has been constructed using basic shapes.

a. Explain two methods of calculating the area of the letter using:
i. addition **ii.** subtraction.

b. Using your preferred method, calculate the area of the letter.



10.7 Volume of rectangular prisms

LEARNING INTENTION

At the end of this subtopic you should be able to:
- calculate the volume of a rectangular prism.

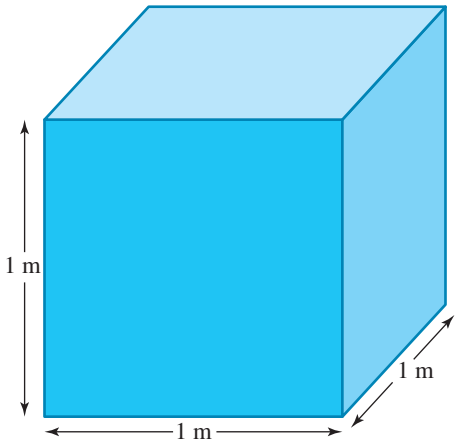
eles-4559

10.7.1 Volume

- The **volume** of a **3-dimensional object** is the amount of space it occupies.
- Volume is measured in cubic units such as mm^3, cm^3 and m^3.
- A cubic centimetre (cm^3) is the space occupied by a cube with sides of 1 cm.

A sugar cube has a volume of about 1 cm^3.

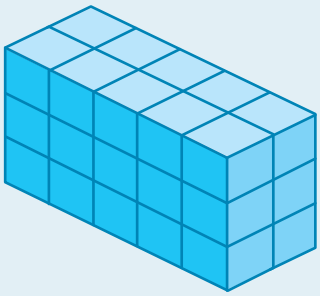
A cubic metre (m^3) is the space occupied by a cube with sides of 1 m.



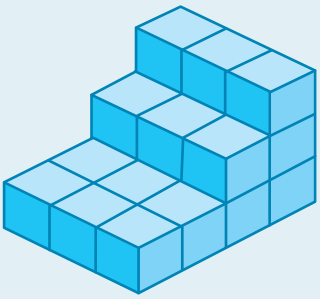
WORKED EXAMPLE 14 Counting cubes in solid shapes

Calculate how many cubic centimetres are in each solid shape. (Each small cube represents 1 cm^3.)

a.



b.

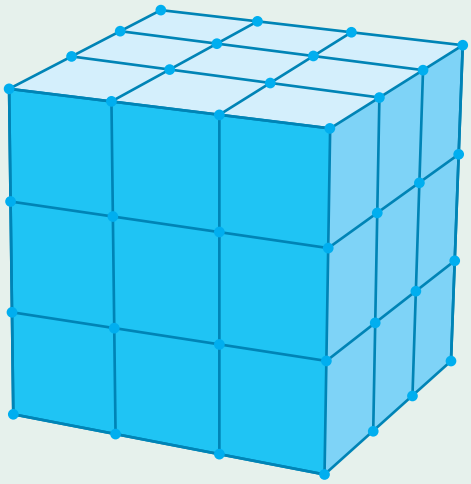


THINK	WRITE
a. 1. Count the cubes. There are 10 cubes in each layer. There are three layers altogether.	**a.** Volume $= 10\,cm^3 \times 3$
2. Give the answer in cubic centimetres.	$= 30\,cm^3$
b. 1. Count the cubes. There are 12 cubes in the first layer. There are 6 cubes in the second layer. There are 3 cubes in the third layer.	**b.** Volume $= 12\,cm^3 + 6\,cm^3 + 3\,cm^3$
2. Give the answer in cubic centimetres.	$= 21\,cm^3$

COLLABORATIVE TASK: The blue cube

Work in pairs to answer the following questions.

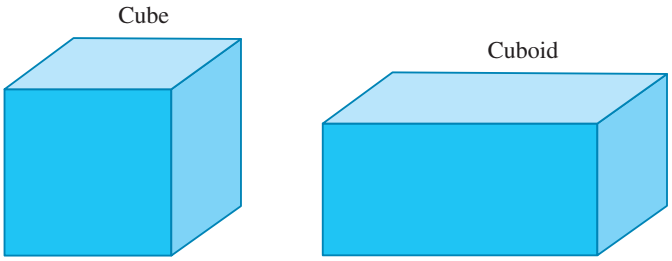
1. The outside of a cube with 3 cm sides is painted blue. The cube is then cut into smaller cubes, each with sides 1 cm long. How many of the 1 cm cubes will have paint on:
   - **a.** 1 side only
   - **b.** 2 sides only
   - **c.** 3 sides only
   - **d.** no sides?
2. For a cube with 4 cm sides, made from 1 cm cube blocks and painted blue on the outside, determine the number of cubes painted on:
   - **a.** 1 side only
   - **b.** 2 sides only
   - **c.** 3 sides only
   - **d.** no sides.
3. Repeat question **2** for a cube with sides of 5 cm.
4. Is there a pattern that you can use to predict the numbers of cubes with paint on one, two, three or no sides if you know the number of cubes along the side of the large cube?



eles-4560

10.7.2 Calculating the volume of a rectangular prism

- A cube is a 6-sided 3-dimensional shape in which all sides are squares.
- A cuboid is a 6-sided 3-dimensional shape in which all sides are rectangles or squares.
- Cuboids are also known as rectangular **prisms**.

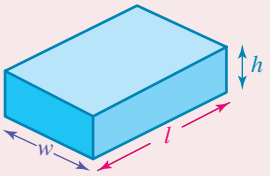


Volume of a rectangular prism

For a rectangular prism, the volume V is:

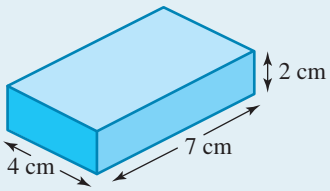
$$V = l \times w \times h$$
$$= lwh$$

where l is its length, w its width and h its height.



WORKED EXAMPLE 15 Calculating the volume of a rectangular prism

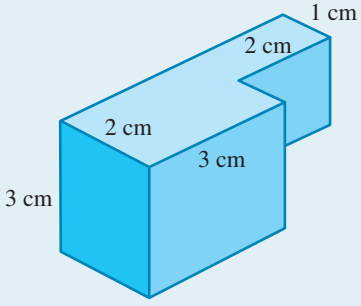
Use the formula $V = lwh$ to calculate the volume of the following rectangular prism.



THINK	WRITE
1. State the formula for the volume of a rectangular prism.	$V = lwh$
2. Identify the length ($l = 7$ cm), width ($w = 4$ cm), and height ($h = 2$ cm) of the prism and substitute the values into the formula.	$= 7\text{ cm} \times 4\text{ cm} \times 2\text{ cm}$
3. Calculate the volume, stating the answer in the appropriate units (cm^3).	$= 56\text{ cm}^3$

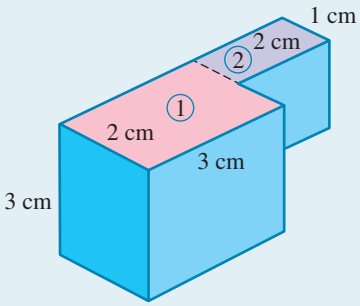
WORKED EXAMPLE 16 Calculating the volume of a composite rectangular prism

Use the information given in the diagram to calculate the volume of the composite rectangular prism.



THINK	WRITE
1. To calculate the volume, first write the formula for the volume of a rectangular prism.	$V = lwh$

2. Split the shape into 2 rectangular prisms and calculate the volume of each rectangular prism.



Volume of rectangular prism 1 $= 3 \times 2 \times 3$
$= 18\ \text{cm}^3$
Volume of rectangular prism 2 $= 2 \times 1 \times 3$
$= 6\ \text{cm}^3$

3. Add the volumes to determine the volume of the composite rectangular prism.

$V = 18\ \text{cm}^3 + 6\ \text{cm}^3$
$= 24\ \text{cm}^3$

Resources

eWorkbook Topic 10 Workbook (worksheets, code puzzle and project) (ewbk-1911)

Digital documents SkillSHEET Volume units (doc-6516)
SkillSHEET Volume of a solid constructed from cubic-centimetre blocks (doc-6517)

Interactivities Individual pathway interactivity: Volume of rectangular prisms (int-8470)
Volume (int-4021)
Volume of a rectangular prism (int-4022)

Exercise 10.7 Volume of rectangular prisms

learnON

Individual pathways

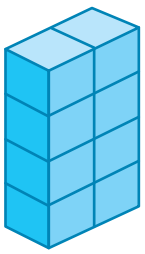
PRACTISE	CONSOLIDATE	MASTER
1, 2, 6, 9, 13, 16, 21, 24	3, 5, 7, 10, 11, 14, 17, 19, 22, 25	4, 8, 12, 15, 18, 20, 23, 26

To answer questions online and to receive **immediate corrective feedback** and **fully worked solutions** for all questions, go to your learnON title at www.jacplus.com.au.

Fluency

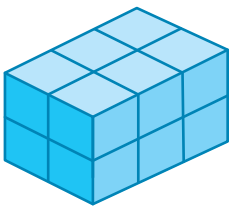
1. WE14a Calculate how many cubic centimetres are in each solid shape. (Each small cube represents 1 cm^3.)

a.

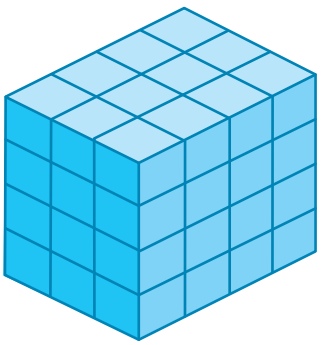


b.

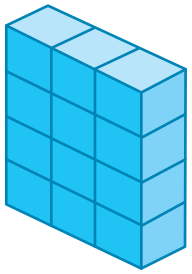
c.



d.



2. MC Select the volume of the prism shown.

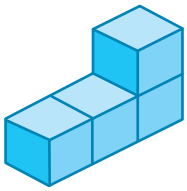


A. 4 cm^3
B. 12 cm^3
C. 1 cm^3
D. 8 cm^3
E. 19 cm^3

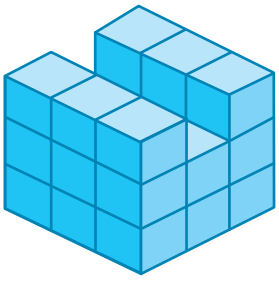
Note: Each cube has a volume of 1 cm^3.

3. WE14b Calculate the volumes of the following solids. (Each small cube represents 1 cm^3)

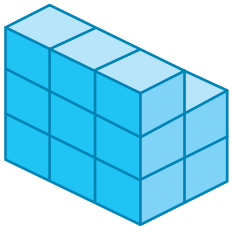
a.



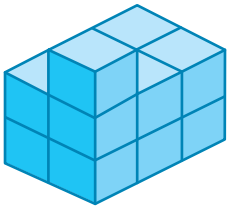
b.



c.

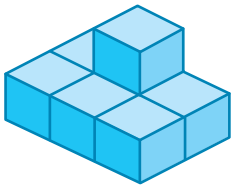


d.

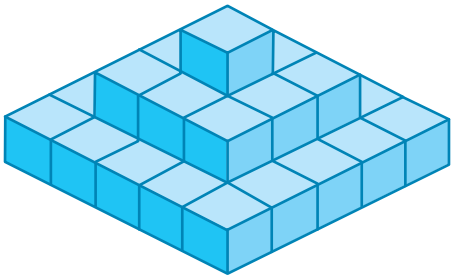


4. Calculate the volumes of the following solids. (Each small cube represents 1 cm^3)

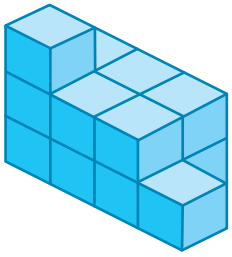
a.



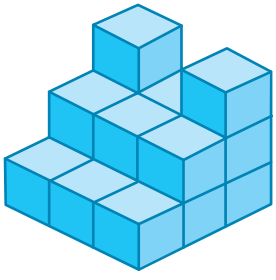
b.



c.



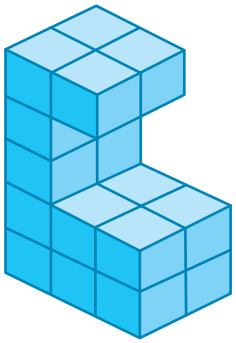
d.



5. MC Select the volume of the prism shown.

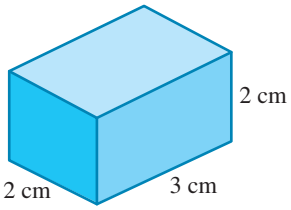
A. 20 cm^3
B. 16 cm^3
C. 10 cm^3
D. 22 cm^3
E. 3 cm^3

Note: Each cube has a volume of 1 cm^3.

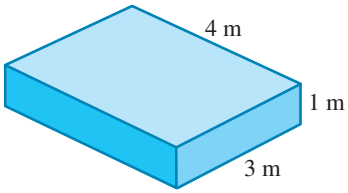


6. WE15 Use the formula $V = lwh$ to calculate the volumes of the following rectangular prisms.

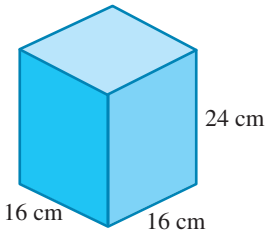
a.



b.

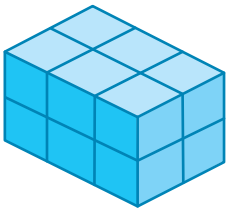


c.

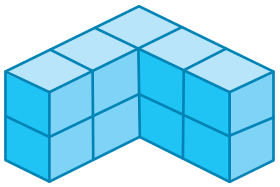


7. Determine the volume of each of the following. (Each cube has a volume of 1 cm^3.)

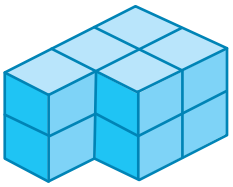
a.



b.

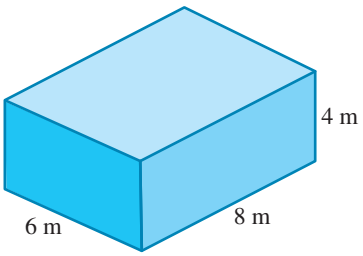


c.

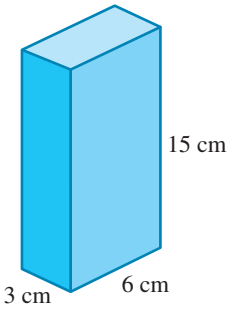


8. Use the formula $V = lwh$ to calculate the volumes of the following rectangular prisms.

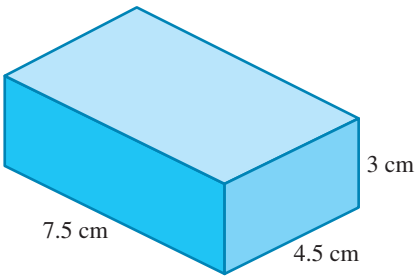
a.



b.



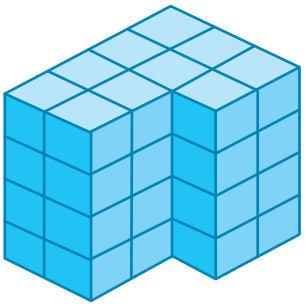
c.



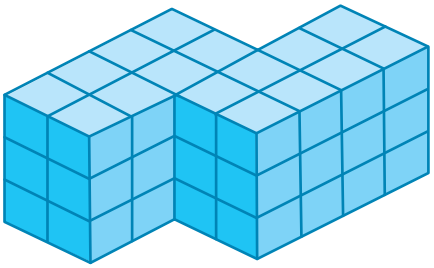
9. MC Select the volume of the prism shown.

A. 10 cm^3
B. 20 cm^3
C. 30 cm^3
D. 40 cm^3
E. 80 cm^3

Note: Each cube has a volume of 1 cm^3.



10. MC Select the volume of the prism shown.

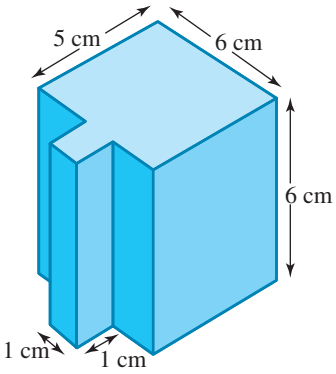


A. 16 cm^3
B. 48 cm^3
C. 32 cm^3
D. 40 cm^3
E. 160 cm^3

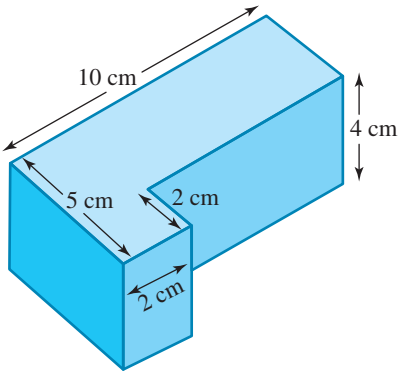
Note: Each cube has a volume of 1 cm^3.

11. WE16 Calculate the volumes of the following composite prisms.

a.

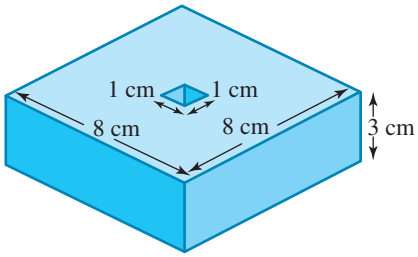


b.

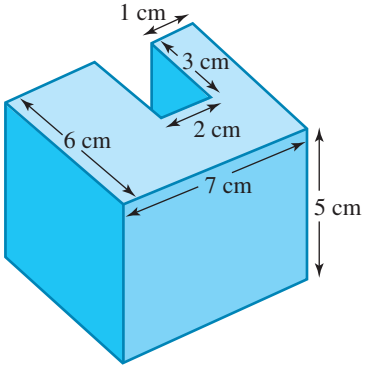


12. Calculate the volumes of the following composite prisms.

a.



b.



Understanding

13. Calculate the volume of the shoe box shown. (Give your answer in cm^3.)

14. The inside dimensions of a refrigerator are shown. Calculate the volume available for food storage inside the refrigerator.

15. **a.** A rectangular prism has a length of 30 cm and a width of 15 cm. If its volume is 9000 cm^3, determine its height.

b. A rectangular prism has a length of 13 cm and a width of 17 cm. If its volume is 1989 cm^3, determine its height.

c. A rectangular prism has a length of 10 cm and a width of 15 cm. If its volume is 1800 cm^3, determine its height.

16. The lunch box shown is a rectangular prism.

a. Calculate the volume of the lunch box in cubic centimetres.

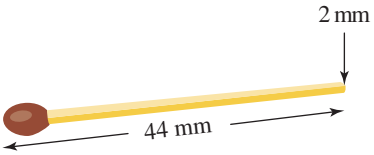
b. Change each measurement to millimetres and hence calculate the volume of the lunch box in cubic millimetres.

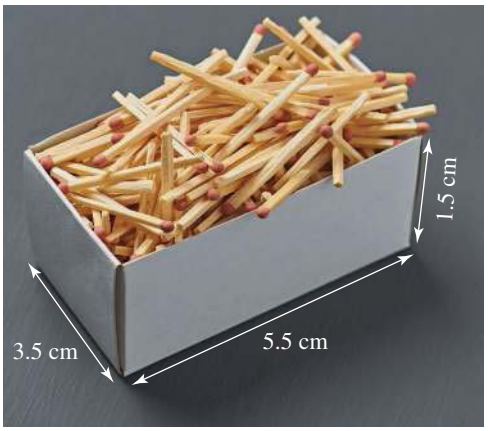
17. Determine the volume of concrete (in cubic metres) that would be needed to make the base for a garage that is 6.5 m wide and 3 m long. The concrete base is 0.25 m deep.

18. **a.** Calculate the volume (in cubic centimetres) of the matchbox shown.

b. Change each measurement to millimetres and hence determine the volume of the matchbox in cubic millimetres.

c. Matches are rectangular prisms of length 44 mm, width 2 mm and height 2 mm. Calculate the volume of a match (in cubic millimetres). (Ignore the red substance on the end of each match.)



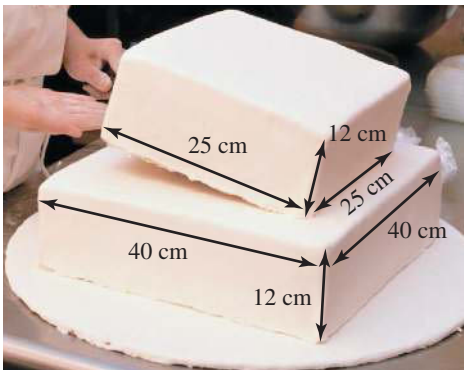


d. If a matchbox contains 50 matches, determine how much space is left in a full box.

19. Calculate how many cubic metres of water would be needed to fill a diving pool that has a length of 16 m, a width of 12 m and a depth of 4 m.

20. Heather wishes to cover a rectangular lawn with topsoil to a depth of 0.1 m. If the lawn is 24 m long and 17 m wide, calculate the volume of soil (in cubic metres) she needs to order.

Reasoning

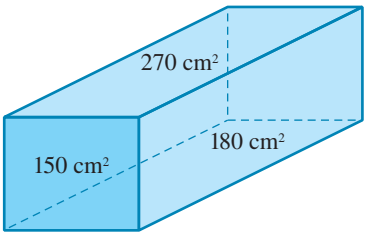


21. The fruitcake shown in the photo is to be divided equally among 100 people at a wedding reception. Determine the volume of cake (in cubic centimetres) each guest will receive.

22. A swimming pool is rectangular and its width is exactly half its length. Determine the volume of water needed to fill it if the swimming pool is 50 metres long and has a constant depth of 2 metres.

23. A new rectangular patio has been built on the end of your house. It measures 3.8 m by 1.9 m. You want to plant a garden that is 1.5 m wide around the patio on three sides. The garden beds are to be 0.5 metres deep. If you order 7.3 cubic metres, explain with a diagram whether enough soil has been ordered.

Problem solving



24. Calculate the volume of clay in a house brick that has a length of 23 cm, a width of 11 cm and a height of 9 cm.

25. The areas of the three sides of a rectangular box are shown in the diagram. Determine the volume of the box, showing all your working.

26. A big cargo box measures 12 m by 6 m by 5 m. Determine how many small boxes of 40 cm by 25 cm by 10 cm can fit in the cargo box.

10.8 Capacity

LEARNING INTENTION

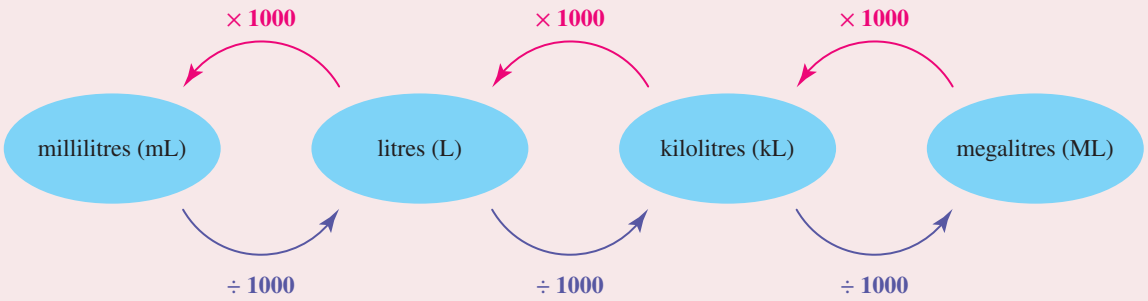
At the end of this subtopic you should be able to:
- calculate the capacity of a container
- convert between units of volume and capacity.

10.8.1 Capacity

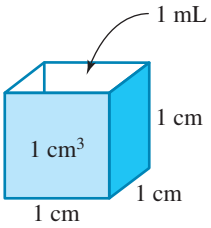
eles-4561

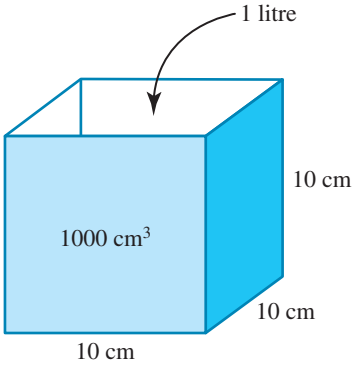
- The **capacity** of a container is the volume of liquid that it can hold.
- Capacity is commonly measured in millilitres (mL), litres (L), kilolitres (kL) and megalitres (ML).
- The following chart can be used to convert between megalitres, kilolitres, litres and millilitres.

Capacity conversion



- Capacity can be measured in the same units as volume (e.g. cm^3 or m^3).
- The metric volume unit 1 cm^3 has a capacity of 1 mL. The metric capacity unit 1 L is equivalent to 1000 cm^3.





WORKED EXAMPLE 17 Converting between different units of capacity

Complete the following unit conversions.

a. **6 L = _____mL** **b.** **700 mL = _____L** **c.** **0.45 L = _____cm^3**

THINK	WRITE
a. Check the conversion chart. To convert litres to millilitres, multiply by 1000. Since 6 is a whole number, do this by adding three zeros to the end of the number.	**a.** $6\text{ L} = 6 \times 1000\text{ mL}$ $= 6000\text{ mL}$
b. Check the conversion chart. To convert millilitres to litres, divide by 1000. To do this, move the decimal point 3 places to the left.	**b.** $700\text{ mL} = 700 \div 1000\text{ L}$ $= 0.7\text{ L}$
c. Check the conversion chart. To convert litres to millilitres, multiply by 1000. To do this, move the decimal point 3 places to the right. Note that $1\text{ mL} = 1\text{ cm}^3$.	**c.** $0.45\text{ L} = 0.45 \times 1000\text{ mL}$ $= 450\text{ mL}$ $= 450\text{ cm}^3$

DISCUSSION

How would you explain the difference between volume and capacity?

on Resources

eWorkbook Topic 10 Workbook (worksheets, code puzzle and project) (ewbk-1911)

Interactivities Individual pathway interactivity: Capacity (int-4361)
Capacity (int-4024)

Exercise 10.8 Capacity

learnON

Individual pathways

PRACTISE	CONSOLIDATE	MASTER
1, 4, 7, 10, 13, 15, 17, 20	2, 5, 8, 11, 14, 18, 21, 22	3, 6, 9, 12, 16, 19, 23, 24, 25

To answer questions online and to receive **immediate corrective feedback** and **fully worked solutions** for all questions, go to your learnON title at www.jacplus.com.au.

Fluency

1. WE17a, b Complete the following unit conversions.
   a. 2 L = _____ mL
   b. 3000 mL = _____ L
   c. 7000 mL = _____ L
   d. 5500 mL = _____ L

2. Complete the following unit conversions.
   a. $2\frac{1}{2}$ L = _____ mL
   b. 32 000 mL = _____ L
   c. 0.035 L = _____ mL
   d. 420 L = _____ mL

3. Complete the following unit conversions.
   a. $1\frac{87}{100}$ L = _____ mL
   b. 22 500 mL = _____ L
   c. $\frac{1}{10}$ L = _____ mL
   d. 25 L = _____ kL

4. WE17c Complete the following unit conversions.
   a. 750 cm^3 = _____ mL
   b. 2500 m^3 = _____ kL
   c. 2.45 L = _____ m^3
   d. 78 000 cm^3 = _____ L

5. Complete the following unit conversions.
   a. 40 000 cm^3 = _____ mL = _____ L
   b. 6 L = _____ mL = _____ cm^3
   c. 5200 L = _____ kL = _____ m^3

6. MC A capacity of 25 L is equal to:
   A. 0.025 mL B. 250 mL C. 0.25 mL D. 25 000 mL E. 2500 mL

7. MC A capacity of 35 400 mL is equal to:
   A. 35 400 000 L B. 0.354 L C. 3.5400 L D. 35.4 L E. 35 L

8. Arrange in order from smallest to largest:
   a. $2\frac{1}{2}$ L, 25 000 mL, $\frac{1}{4}$ L, 2.45 L
   b. 760 mL, 0.765 L, 7.65 mL, 7.60 L
   c. 110 mL, 0.1 L, 0.011 L, 1.1 L

Understanding

9. A water bottle has a capacity of 2 litres. Calculate how many 125 mL bottlefuls are required to fill it.

10. A bottle contains 250 mL of orange juice concentrate. Calculate how much water should be added to make up 2 L of juice from the concentrate.

11. A scientist dilutes (waters down) an acid solution by adding 120 mL of acid to 1.5 L of water. Calculate how much of the diluted solution this will make.

12. Most sports drinks are sold in 500 mL bottles. Calculate how many litres of sports drink are in one dozen (12) bottles.

13. A medicine bottle contains 125 mL of cough syrup. Calculate how many 2.5 mL doses could be administered from this bottle, assuming that none is spilt.

14. Anthea runs a market stall selling detergent. Calculate how many 200 mL bottles of detergent she could fill from a 45 L bulk container.

15. A milk bar sells 55 small bottles of lemon drinks in one week. If each bottle contains 180 mL, calculate how many litres are sold each week.

16. Petrov is working as a school laboratory technician. If there are 12 groups of students and each group requires 400 mL of salt solution for an experiment, calculate how many litres of solution should be prepared.

Reasoning

17. a. Claire has made her favourite green cordial with 0.25 L of water and 30 mL of cordial. Determine whether a glass with a capacity of 250 mL will hold this volume.

b. Sharmila has made fresh juice with 0.3 L of apple juice and 40 mL of carrot juice. Determine whether a glass with a capacity of 350 mL will hold this volume.

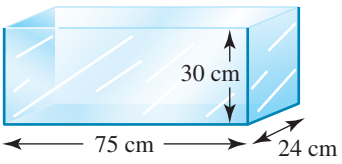
18. A 185 mL container of hair conditioner is sold at the special price of $3.70. A 0.5 L container of the same conditioner costs $11.00. Compare them to identify the better buy. (*Hint:* Calculate the cost of 1 mL of hair conditioner in each case.)

19. Laurie connected a water tank to his 5 m × 3 m roof in order to collect rain water. In four hours, 2 cm of rain fell. The water tank holds 280 litres. Determine whether the tank overflowed. *Hint:* $1000\text{ L} = 1\text{ m}^3$.

Problem solving

20. Determine the number of millilitres of milk the container in the picture holds.

21. Water is to be poured into this fish tank. How many litres of water are needed to fill the tank to a depth of 28 cm?



22. Using the measurements shown in the photo of the sinks, estimate how many litres of water each sink will hold if filled to the top. Both sinks have the same dimensions. (*Hint:* First convert the measurements to centimetres.)

23. One litre of paint covers an area of 20 square metres. Calculate how many millilitres of paint are required to cover an area of 6 square metres. Show your working.

24. A tap drips water at a rate of one drop every three seconds. If it takes 750 drops of water to fill a 100 mL container, determine how many litres of water are lost in one year (365 days).

25. To achieve a world record, a 16.4 kL strawberry milkshake was made in the UK in 1996. To understand how large this is, consider the size of a rectangular prism that would have this capacity. Suggest three possible sets of measurements for this container.

10.9 Drawing solids

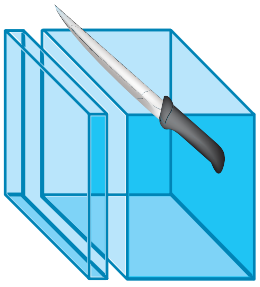
LEARNING INTENTION

At the end of this subtopic you should be able to:
- draw the cross-section of a given prism
- draw the views, or elevations, of a given solid
- construct a solid given its views or elevations.

10.9.1 Prisms

eles-4562

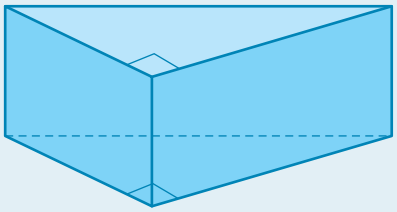
- A prism is a 3-dimensional figure that can be cut into parallel slices or cross-sections that have the same size and shape.



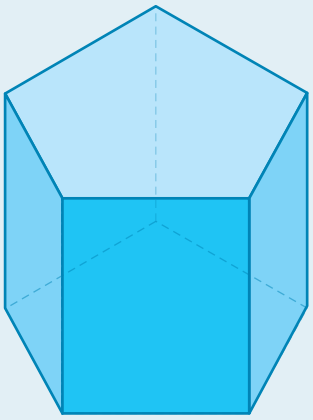
WORKED EXAMPLE 18 Drawing the cross-section of a prism

Draw the cross-section of the following prisms.

a.



b.



THINK

a. 1. Identify the cross-section of the prism that is uniform along the length.

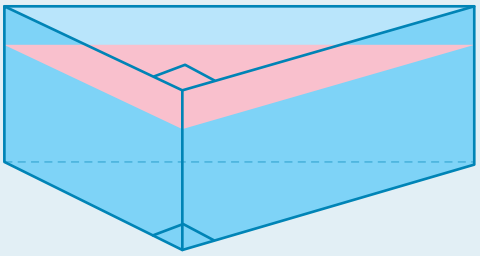
2. Draw the cross-section as a 2-dimensional shape.

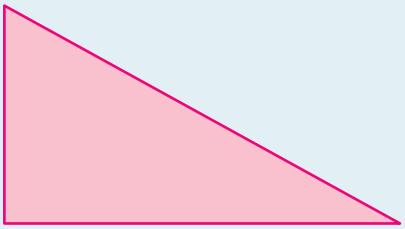
b. 1. Identify the cross-section of the prism that is uniform along the length.

2. Draw the cross-section as a 2-dimensional shape.

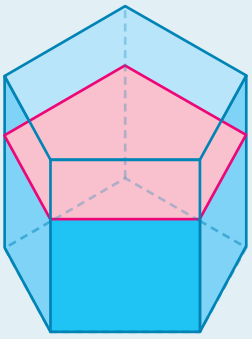
DRAW

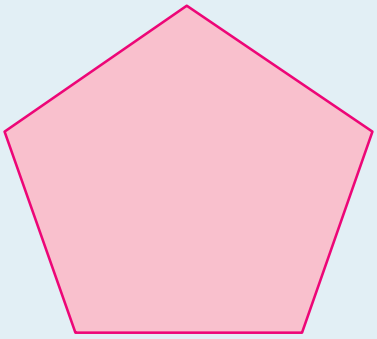
a.





b.





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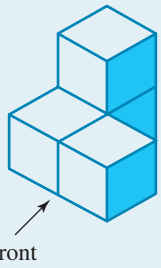
10.9.2 Plans and views

- An object can be viewed from different angles.
- Architects and draftspersons draw plans of buildings viewed from the front, the side or the top.
- The **front view**, or **front elevation**, is what you see if you are standing directly in front of an object.
- The **side view**, or **side elevation**, is what you see if you are standing directly to one side of the object. You can draw the left view or the right view of an object.
- The **top view**, or **bird's eye view**, is what you see if you are hovering directly over the top of the object looking down on it.
- The **back view**, or **back elevation**, is what you see if you are standing directly behind an object.

WORKED EXAMPLE 19 Drawing elevations or views

The following object is made from 4 cubes.
Draw plans of it showing:

a. the front view
b. the right view
c. the top view
d. the back view.



THINK

a. Make this shape using cubes. Place the shape at a considerable distance and look at it from the front (this way you can see only the front face of each cube). Draw what you see. (Or simply imagine looking at the shape from the front and draw what you see.)

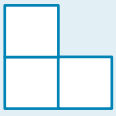
b. Look at your model from the right, or imagine that you can see only the right face of each cube and draw what you see.

c. Look at your model from the top, or imagine that you can see only the top face of each cube. Draw what you see.

d. Imagine that you can only see the shape from behind. Draw what you would see.

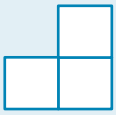
DRAW

a.



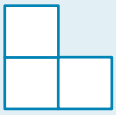
Front view

b.



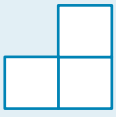
Right view

c.



Top view

Front

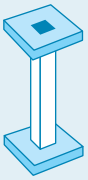


Back view

- As you can see from Worked example 19, the back view is a mirror image of the front view. In fact, for any solid, the back view will always be the mirror image of the front view.
- Figures such as the one in Worked example 19 can be drawn using isometric dot paper. This will help to give the 3-dimensional perspective of the object.

WORKED EXAMPLE 20 Drawing a view of a solid

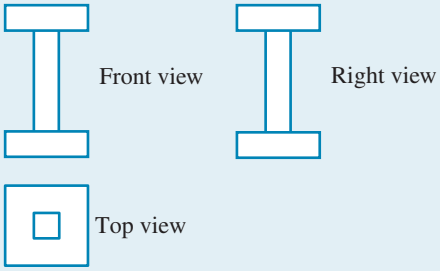
Draw plans of this solid showing:
a. **the front view**
b. **the right view**
c. **the top view.**



THINK

1. Determine an object of similar shape, or visualise the object in your head.
2. Whether viewed from the front, or from the right of the object, the rectangular shaft will appear as a long thin rectangle. The square prisms will also be seen as a pair of identical rectangles. So the front view and the right view are the same.
3. When the object is viewed from above, all we can see is the flat surface of the top square prism: that is, a large and a small square with the same centre.

DRAW



10.9.3 Isometric drawing

eles-4564

- When working with 3-dimensional models and designs, it is often useful to have the design or model drawn on paper (that is, in 2 dimensions).
- An **isometric drawing** is a 2-dimensional drawing of a 3-dimensional object.
- Isometric dot paper can be used to help with these drawings.

WORKED EXAMPLE 21 Completing an isometric drawing of an object

First copy the incomplete figure (Figure 1) onto isometric dot paper. Complete the isometric drawing of the object (Figure 2).

Figure 1

Figure 2

THINK

Study the object and identify the lines that have already been drawn. Fill in the missing lines on your isometric drawing to match the object.

DRAW

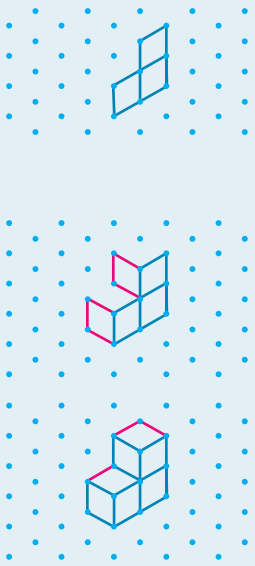
WORKED EXAMPLE 22 Drawing an object on isometric dot paper

Draw the following object on isometric dot paper. (You could construct it from a set of cubes.)

THINK

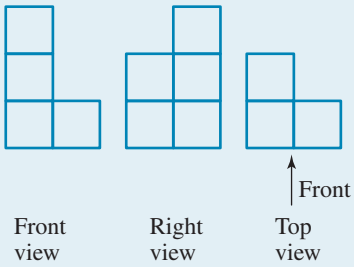
1. Use cubes to make the object shown (optional). Draw the front face of the object. The vertical edges of the 3-dimensional object are shown with vertical lines on the isometric drawing; the horizontal edges are shown with the lines at an angle (by following the dots on the grid paper).
2. Draw the left face of the object.
3. Add the top face to complete the isometric drawing of the object.

DRAW



WORKED EXAMPLE 23 Constructing a solid from given information

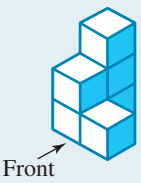
The front, right and top views of a solid are shown. Use cubes to construct the solid, then sketch the solid.



THINK

1. Use cubes to construct the solid.
2. Check carefully that your solid matches each of the 3 views you are given. Make adjustments if necessary.

CONSTRUCT



COLLABORATIVE TASK: Build it!

Equipment: building blocks

For this activity, you will work in groups of three or four as directed by your teacher.

1. Stack ten building blocks in any formation. An example is shown.
2. Draw diagrams of the formations you have assembled to show:
   a. the top view
   b. the front view
   c. the side view.
3. Dismantle your formation. Swap your drawings with another group and ask them to build your formation by using your diagrams.

DISCUSSION

In your small groups from the previous activity, discuss some of the uses of these types of drawings. In which professions might these types of drawings be used?

on Resources

eWorkbook Topic 10 Workbook (worksheets, code puzzle and project) (ewbk-1911)

Interactivities Individual pathway interactivity: Plans and views (int-4392)
Prisms (int-4148)
Plans and views (int-4149)

Exercise 10.9 Drawing solids

learnON

Individual pathways

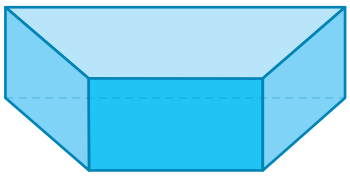
PRACTISE	CONSOLIDATE	MASTER
1, 3, 7, 8, 10, 12, 16, 19, 20	2, 4, 5, 9, 11, 14, 17, 21	6, 13, 15, 18, 22, 23

To answer questions online and to receive **immediate corrective feedback** and **fully worked solutions** for all questions, go to your learnON title at www.jacplus.com.au.

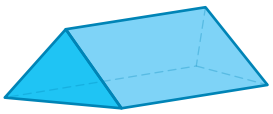
Fluency

1. WE18 Draw the cross-sections of the following prisms.

a.

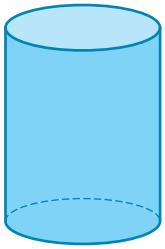


b.

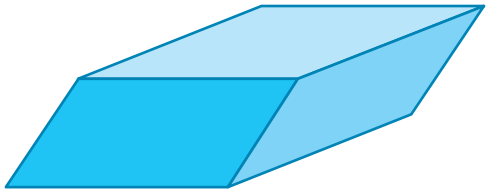


2. Draw the cross-sections of the following prisms.

a.

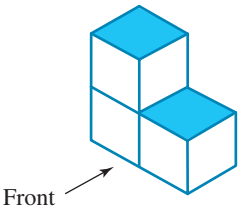


b.

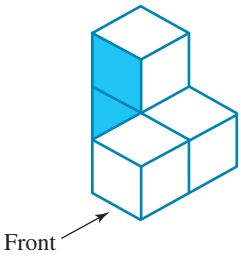


3. WE19 The following objects are made from cubes. For each object draw the plans, showing the front view, the right view, the top view and the back view. (You may wish to use a set of cubes or building blocks to help you.)

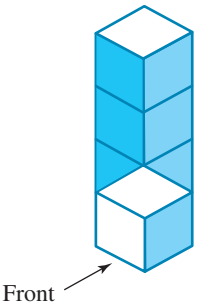
a.



b.

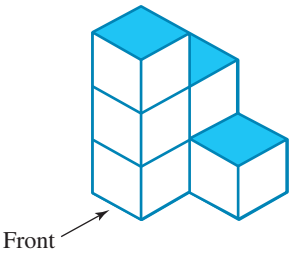


c.

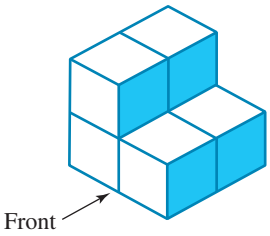


4. The following objects are made from cubes. For each object draw the plans, showing the front view, the right view, the top view and the back view. (You may wish to use a set of cubes or building blocks to help you.)

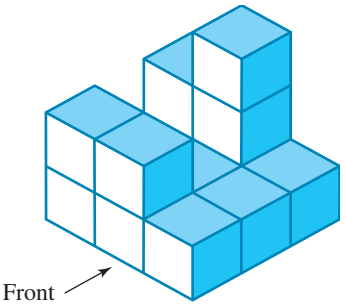
a.



b.

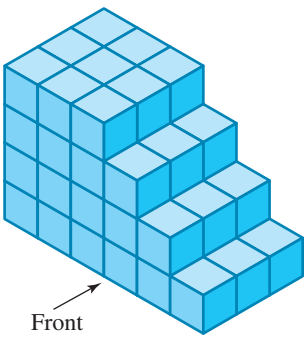


c.

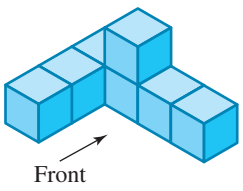


5. Draw the front, right and top views of these objects.

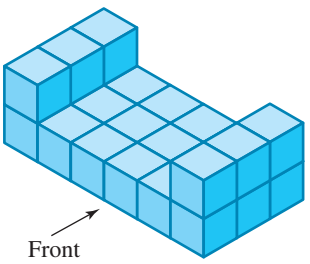
a.



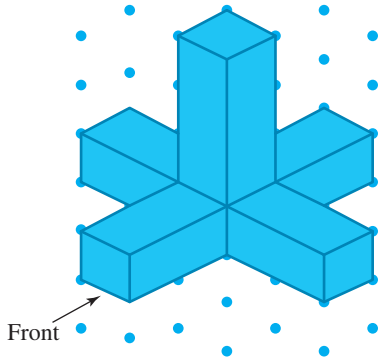
b.



c.



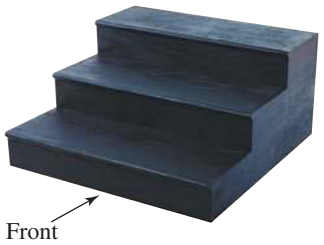
6. Draw the top, front and side views of the object shown in the following isometric drawing.



7. **WE20** Draw the front, right and top views of each solid shown.

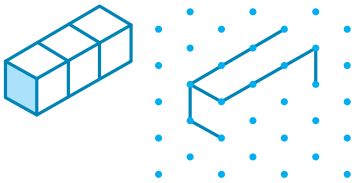
a.

b.

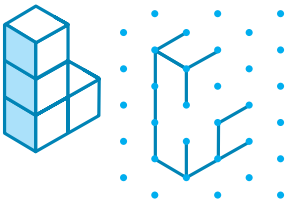


8. **WE21** Copy the following figures onto isometric dot paper and complete the isometric drawing of the objects shown.

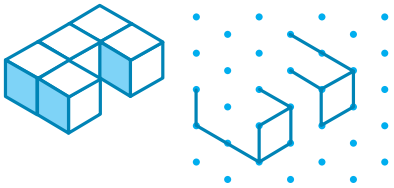
a.



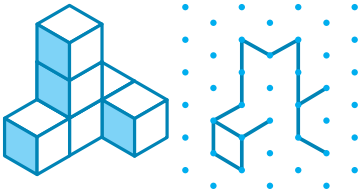
b.



c.



d.

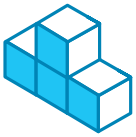


9. **WE22** Draw each of the following objects on isometric dot paper. (You might wish to make them first from a set of cubes.)

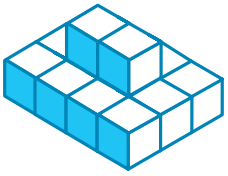
a.

b.

c.



d.

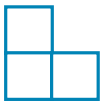


Understanding

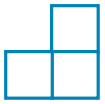
10. WE23 The front, right and top views of a solid are shown. In each case, use cubes to construct the solid, then sketch the solid.

a.

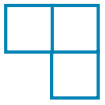
Front view



Right view

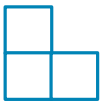


Top view



b.

Front view



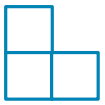
Right view

Top view

11. The front, right and top views of a solid are shown. In each case, use cubes to construct the solid, then sketch the solid.

a.

Front view



Right view

Top view

b.

Front view

Right view

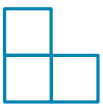
Top view

12. MC The front, right and top views of a solid are shown. Select the correct solid represented by these views.

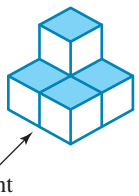
Front view

Right view

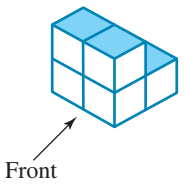
Top view



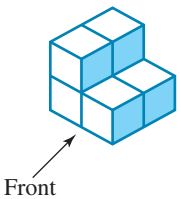
A.



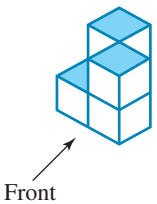
B.



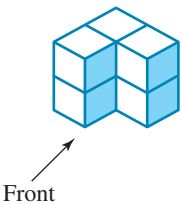
C.



D.



E.



13. Construct the following letters using cubes, and then draw the solids on isometric dot paper:

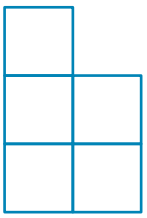
a. the letter T with 5 cubes
b. the letter L with 7 cubes
c. the letter E with 10 cubes
d. the letter H with 7 cubes.

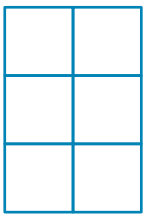
14. Draw the following figure on isometric dot paper.

15. Draw a selection of buildings from this photograph of a city skyline on isometric dot paper.

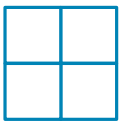
Reasoning

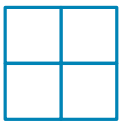
16. Consider the shapes with the following front and right views.
Determine the minimum number of cubes that could be used to construct the shape with the following views.
Determine the maximum number of cubes that could be used. Explain your reasoning.

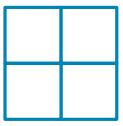
Front view 

Right view 

17. A shape is made using only 4 cubes. Its front view, right view and top view are shown.

Front view 

Right view 

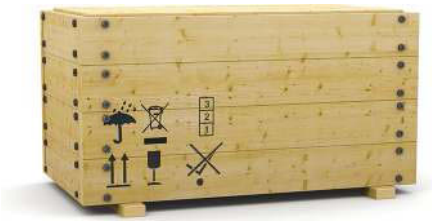
Top view 

a. Explain whether it is possible to construct this solid.
b. Describe or draw what this solid would look like.

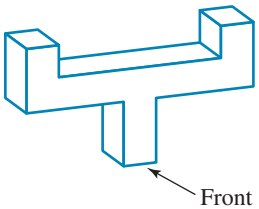
18. How many objects can you construct using the top view shown? Explain your answer with the use of diagrams.

Problem solving

19. On the same isometric dot paper, draw the two wooden boxes shown.

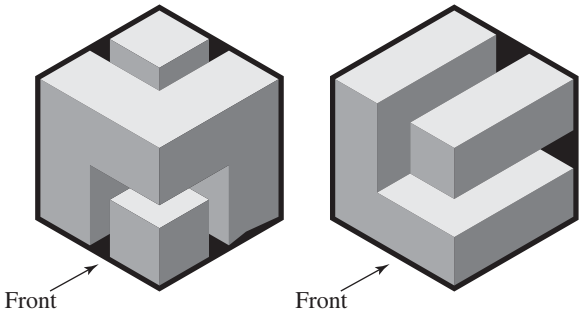


20. Draw the plans of the following diagram, showing the front view, right view and top view.



21. Jonah is building a brick wall as shown in the photograph. Draw this part of the wall on isometric dot paper.

22. Draw top, front and side views for the 3D objects shown.



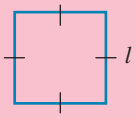
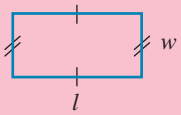
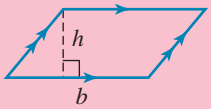
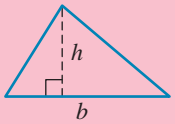
23. Sam has a set of wooden cube blocks he uses to build different shapes. His sister Chris challenged him to see how many different ways he could stack 4 cubes. He can only stack them on top of each other or side by side — not one behind the other. The arrangements must be different and not simply be a mirror image or rotation of another shape. Draw the different arrangements possible.

10.10 Review

10.10.1 Topic summary

Area

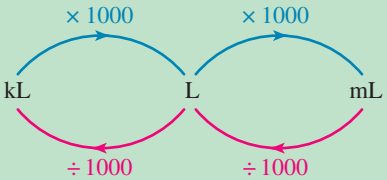
- The area of a shape is the amount of 2-dimensional space within it.
- Area is measured in square units: mm^2, cm^2 m^2 and km^2
- The area formulas for some common shapes are listed below.

Shape	Area formula
Square 	$A = l \times l$ $= l^2$
Rectangle 	$A = l \times w$
Parallelogram 	$A = b \times h$
Triangle 	$A = \frac{1}{2} \times b \times h$

- The hectare, ha, is a non-SI metric unit of area equal to a square with sides of 100 m.
  1 ha = 10 000 m^2

Capacity

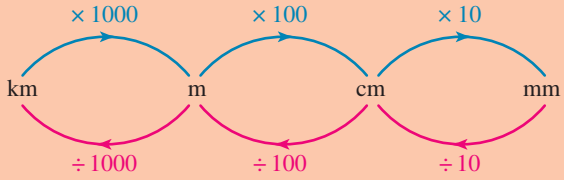
- The amount of liquid an object can hold is known as its *capacity*.
- Capacity can be measured in cubic units (cm^3 or m^3); however, it is more commonly measured in millilitres (mL), litres (L), kilolitres (kL) or megalitres (ML).
- You can convert between these units by using the diagram below.



1000 mL = 1 L
1000 L = 1 kL
1 cm^3 = 1 mL
1000 cm^3 = 1 L

Units of length

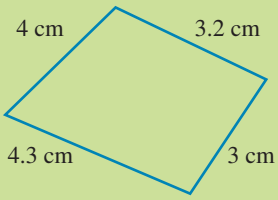
- The modern metric system in Australia is defined by the International System of Units (SI).
- The most common units of length are millimetres (mm), centimetres (cm), metres (m) and kilometres (km).
- You can convert between these units by using the diagram below.



e.g.
3.4 m = 3.4 × 100 × 10 mm = 3400 mm

Perimeter

- The perimeter, *P*, is the distance around a closed shape.
- When calculating the perimeter of a shape, make sure all lengths are in the same units before adding them together.



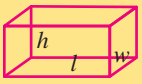
$P = 4 + 3.2 + 3 + 4.3 = 14.5$ cm

MEASUREMENT

Volume

- Volume is the amount of 3-dimensional space an object takes up.
- Volume is measured in cubic units: mm^3, cm^3, m^3 and km^3.
- A prism is a solid object with identical ends, flat faces and the same cross-section along its length.
- The volume of a rectangular prism is given by:

$V = l \times w \times h$



10.10.2 Success criteria

Tick the column to indicate that you have completed the subtopic and how well you think you have understood it using the traffic light system.

(**Green:** I understand; **Yellow:** I can do it with help; **Red:** I do not understand)

Subtopic	Success criteria			
10.2	I can convert between different units of length.			
10.3	I can read and interpret various scales.			
10.4	I can calculate the perimeter of a given shape.			
	I can calculate the perimeter of rectangles and squares.			
10.5	I can calculate, or estimate, the area of a given shape.			
	I can calculate the area of rectangles, squares, triangles and parallelograms using formulas.			
10.6	I can separate composite shapes into simple shapes.			
	I can calculate the area of composite shapes by adding or subtracting areas of simple shapes.			
10.7	I can calculate the volume of a rectangular prism.			
10.8	I can calculate the capacity of a container.			
	I can convert between units of volume and capacity.			
10.9	I can draw the cross-section of a given prism.			
	I can draw the views, or elevations, of a given solid.			
	I can construct a solid given its views or elevations.			

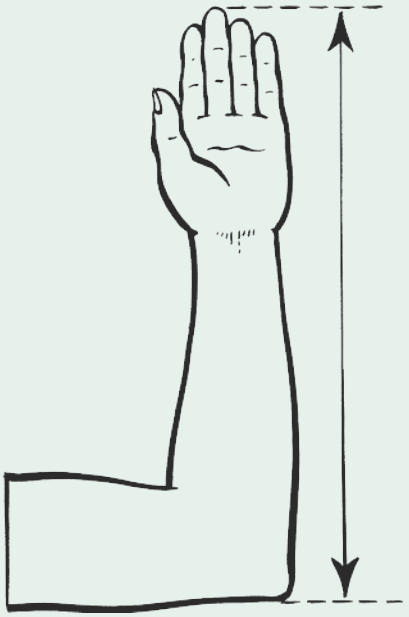
10.10.3 Project

Old units of length

When studying length and perimeter, you learned about the common metric units of length: millimetre, centimetre, metre and kilometre. It's only in the last few decades that these units have been commonly used in Australia. Prior to this, the units of length were based on the imperial system. Most countries in the world use units based on the metric system, but a few continue to use imperial units.

The origins of the imperial units are far and wide. Many have been adapted from ancient times or translated into English from other languages. Other units, as strange as it may seem, are based on parts of the body.

The ancient Egyptians built the Great Pyramid of Giza over four and a half thousand years ago. It was constructed with side lengths of 440 cubits and was 280 cubits high.



The *cubit* was a unit equal to the 'length of the forearm of the bent elbow to the tip of the extended middle finger'.

1. The metric height of the Great Pyramid of Giza is 146.5 metres; its base length is 230 metres. Use these to determine the value of the cubit to 3 decimal places.
2. Below are some units of length from the imperial system. Select five units, and calculate their equivalent in the metric system. Find out where and how they were used (what sorts of objects they measured, in what situations they were used — for example, for small or large distances, for racetracks, for the depth of water or in land surveying).

league	hand	line	mile
furlong	chain	inch	link
rod	foot	yard	fathom

Although Australians have used units of length from the metric system for over 3 decades, many institutions have stuck with units common to the imperial system. For example, a cricket pitch is still 22 yards long.

3. Find another sport that still uses lengths associated with the imperial system and state the unit(s) involved.

Resources

eWorkbook Topic 10 Workbook (worksheets, code puzzle and project) (ewbk-1911)

Interactivities Crossword (int-2600)
Sudoku puzzle (int-3170)

Exercise 10.10 Review questions

learnON

To answer questions online and to receive **immediate corrective feedback** and **fully worked solutions** for all questions, go to your learnON title at www.jacplus.com.au.

Fluency

1. Identify which metric unit would be most suitable for measuring:
   a. the distance walked by a teacher at school during a week
   b. the length of a piece of spaghetti
   c. the width of a pencil.

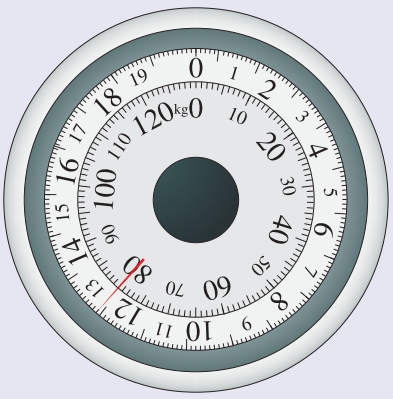
2. Complete the following conversions.
   a. 560 mm = _____ m
   b. 2300 cm = _____ km
   c. 17 m = _____ cm
   d. $\frac{3}{4}$ km = _____ mm
   e. 2.09 m = _____mm

3. Complete the following conversions.
   a. $6\frac{4}{5}$ cm = _____ m
   b. 22.5 mm = _____ cm
   c. $\frac{63}{10\,000}$ km = _____ m
   d. 82 000 000 m = _____ km
   e. $5\frac{9}{10}$ mm = _____ cm

4. Arrange from smallest to largest: 44.5 m, 455 cm, 455 000 mm, 0.004 45 km.

5. a. Add 45.6 km to 5600 m.
   b. Calculate the difference between 80 m and 4300 cm.

6. Identify the reading in kilograms on this bathroom scale. *Note:* The scale for kilograms is the inner circle.

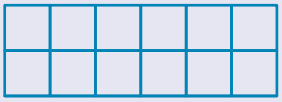


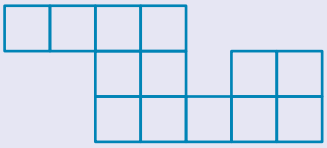
7. Estimate the height of the front tree in the photograph, given that the person standing is 1.7 m tall.

8. Identify which unit of area would be the most appropriate for measuring the following. (Choose from mm^2, cm^2, m^2, ha and km^2.)

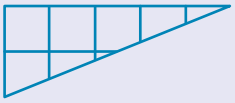
a. The floor area of your classroom
b. The area of the city of Brisbane
c. A pin head
d. A market garden
e. The area of the continent of Antarctica

9. Determine the areas of the following figures, which are drawn on centimetre grid paper.

a.


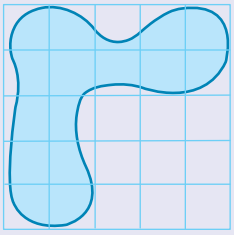
b.


c.

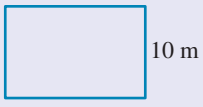

d.


e.

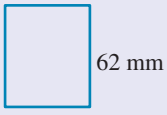

10. Estimate the shaded area in the figure.
Note: Each square on the grid has an area of 1 cm^2



11. Use the formula $A = lw$ to calculate the areas of the following rectangles.

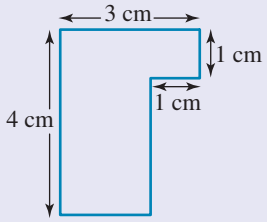
a.


b.

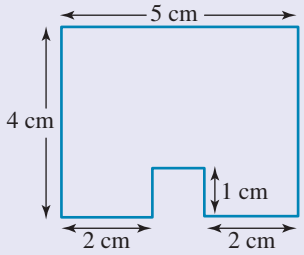

c.


12. Calculate the areas of the following shapes by first dividing them into rectangles.

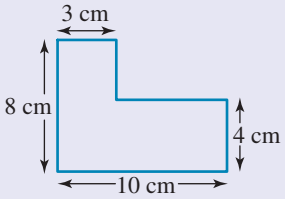
a.



b.

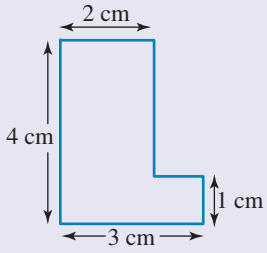


c.

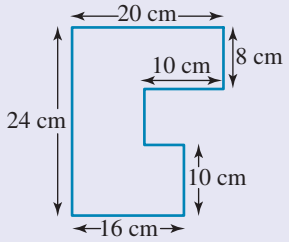


13. Calculate the areas of the following shapes by first dividing them into rectangles.

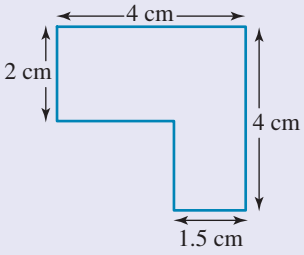
a.



b.

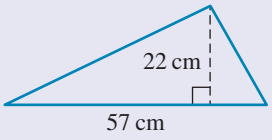


c.

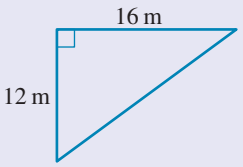


14. Calculate the areas of the following triangles.

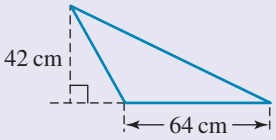
a.



b.

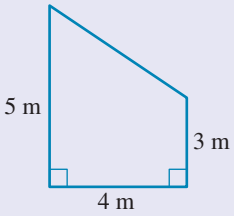


c.

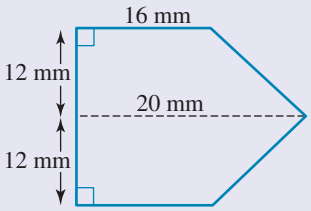


15. Calculate the areas of the following shapes.

a.

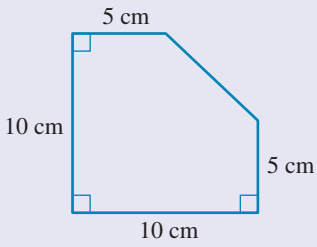


b.

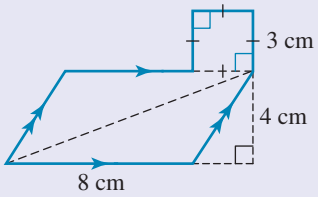


16. Calculate the areas of the following shapes.

a.

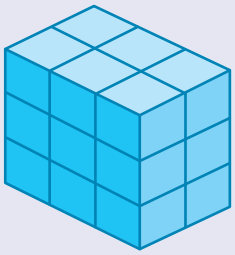


b.

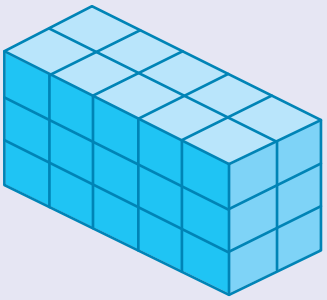


17. Calculate the volume of each shape in cubic centimetres (cm^3). Each cube has a volume of 1 cm^3.

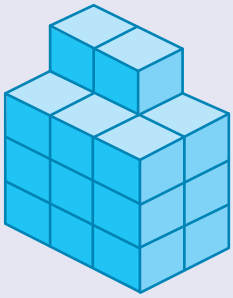
a.



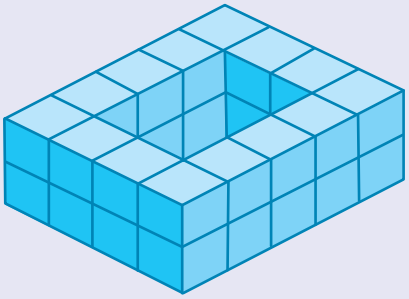
b.



c.

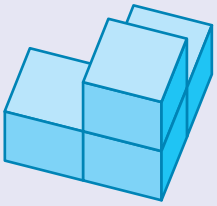


d.

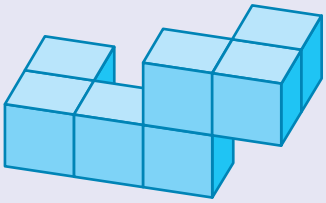


18. Draw the front, right and top views of these objects.

a.

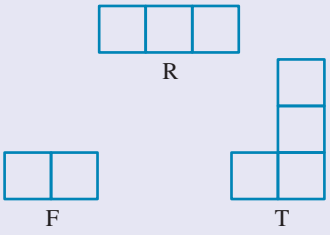


b.

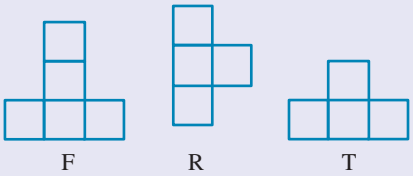


19. Draw isometric views of the objects, whose front (F), right (R) and top (T) views are given here.

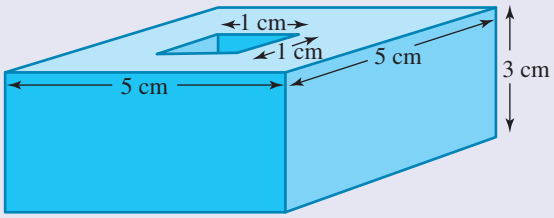
a.



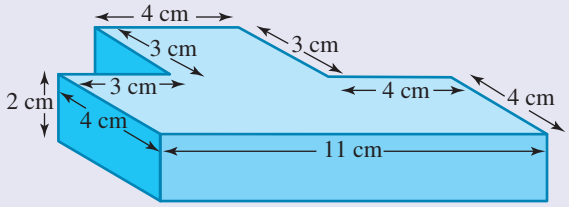
b.



20. Use the information given in the diagram to calculate the volume of the shape.



21. Use the information given in the diagram to determine the volume of the shape.



22. Complete the following conversions.

a. 8 L = _____ mL

b. $\frac{21}{50}$ L = _____ mL

c. 3300 mL = _____ L

d. $1\frac{3}{250}$ L = _____ mL

23. Complete the following conversions.

a. $4\frac{3}{10}$ kL = _____ L

b. 0.0034 kL = _____ L

c. 4755 L = _____ kL

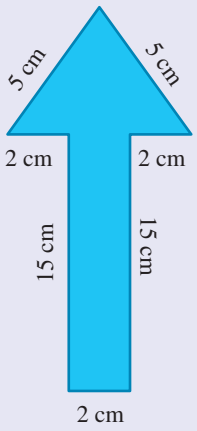
d. 432 mL = _____ L

Problem solving

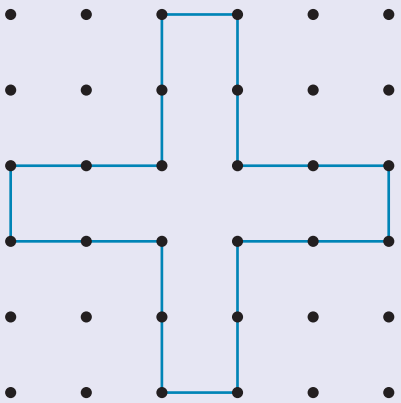
24. During a rescue operation in calm seas, a 16.5 m rope is dangled from a helicopter hovering 20 m above sea level. A man who is 175 cm tall is standing on the deck of a boat when he reaches 50 cm above his head for the rope. By how much does he fail to reach the rope if the deck is 1 m above sea level?

25. Calculate the perimeter of each shape.

a.

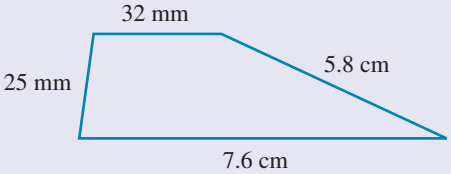


b.

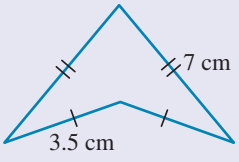


Note: The dots are 1 cm apart.

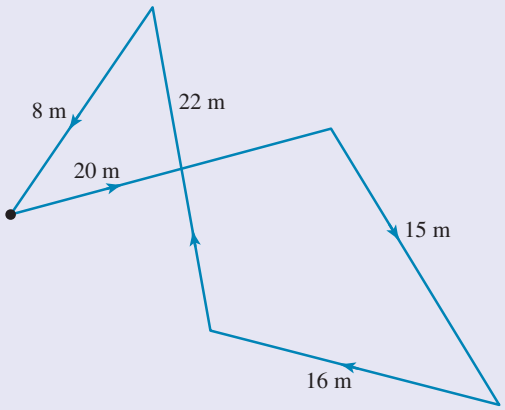
c.



d.



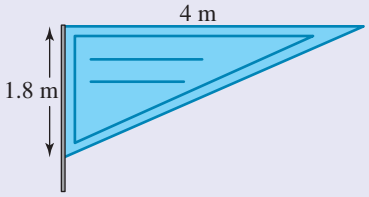
26. Michelle rides three laps of the following dirt-bike track. Calculate how far she rides altogether.



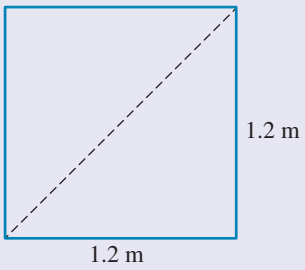
27. Determine the length of satin ribbon required to edge a rectangular blanket on all four sides if the blanket is 240 cm long and 195 cm wide. (Assume there is no overlap.)

28. Determine the cost of paving a rectangular courtyard that is 6.5 m long and 3.2 m wide. The courtyard is to be paved with concrete paving blocks, which cost $28 per square metre.

29. Calculate the area of card needed to make the triangular display sign shown.



30. When making a box kite, Katie cuts a square piece of material diagonally, as shown by the dotted line in the diagram. What is the area of each triangular piece of material?



31. **a.** A rectangular prism has a length of 40 cm and a width of 26 cm. If its volume is 29 120 cm^3, calculate the height of the rectangular prism.

b. A rectangular prism has a length of 30 cm and a width of 15 cm. If its volume is 3825 cm^3, calculate its height.

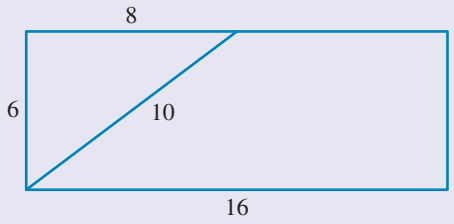
32. In a food technology class, each of the 14 groups of students uses 350 mL of fresh milk to make pancakes. Calculate how many litres of milk should be ordered for the whole class.

33. Mario makes up raspberry cordial by pouring 275 mL of concentrate into a 2-litre container and filling the container with cold water.

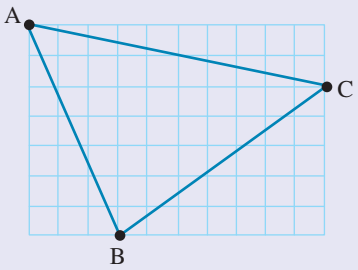
a. Calculate how much cold water Mario needs to add.

b. Calculate how many 250 mL glasses of cordial Mario can pour from the large container.

34. A 6×16 rectangle is cut into two pieces as indicated. The two pieces are rearranged to form a right triangle. Calculate the perimeter of the resulting triangle.



35. Each small square in the following diagram measures 1 cm $\times$ 1 cm. Calculate the area of triangle ABC (in square cm).



36. Stewart is having a swimming pool built in his back yard. The hole for the pool is 6 metres long, 4 metres wide and 1.5 metres deep. The excavated soil becomes aerated as it is dug out, and its volume is increased by $\frac{1}{10}$. Determine the volume of the excavated soil.

37. A rectangular cake is three times as long as it is wide. A layer of icing that is 1 cm thick is spread on top of the cake. If the total volume of icing used is 300 cm^3, determine the dimensions of the top of the cake.

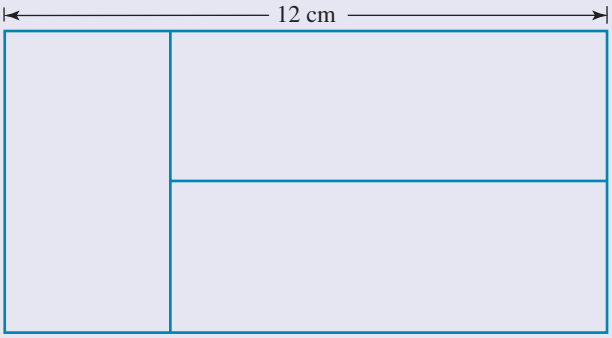
38. A gardener is employed to pave a path that is 2 metre wide around a 10 m $\times$ 5.5 m rectangular swimming pool.

a. Determine the area of the paved path.

b. Determine the minimum number of bricks that should be ordered if there are 60 bricks per square metre.

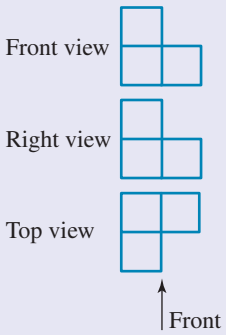
39. The perimeter of a rectangle is 20 cm. Investigate the shape of all such rectangles if the sides are whole numbers. Identify the dimensions of the rectangle with the largest area.

40. The following rectangle is divided into three identical smaller rectangles. The length of the large rectangle is 12 cm.
Determine the width of the large rectangle.

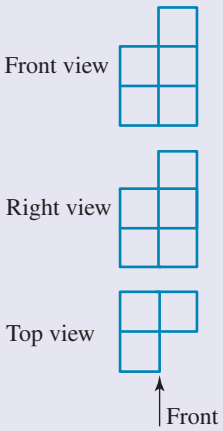


41. The front, side and top views of a solid are shown. Construct this solid using blocks, then sketch the solid.

a.



b.



To test your understanding and knowledge of this topic, go to your learnON title at www.jacplus.com.au and complete the **post-test**.

Online Resources

on Resources

Below is a full list of **rich resources** available online for this topic. These resources are designed to bring ideas to life, to promote deep and lasting learning and to support the different learning needs of each individual.

eWorkbook

Download the workbook for this topic, which includes worksheets, a code puzzle and a project (ewbk-1911) ☐

Solutions

Download a copy of the fully worked solutions to every question in this topic (sol-0699) ☐

Digital documents

10.2 SkillSHEET Metric units of length (doc-6505) ☐
SkillSHEET Measuring the length of a line (doc-6507) ☐
SkillSHEET Relationship between unit size and the number of units used (doc-6508) ☐
SkillSHEET Converting units (doc-6509) ☐
SkillSHEET Converting units to compare lengths and distances (doc-6510) ☐
10.3 SkillSHEET Reading scales (doc-6506) ☐
10.4 SkillSHEET Perimeter (doc-6511) ☐
10.5 SkillSHEET Area units (doc-6512) ☐
SkillSHEET Area of figures drawn on one-centimetre grid paper (doc-6513) ☐
SkillSHEET Area of rectangles (doc-6514) ☐
SkillSHEET Area of triangles (doc-6515) ☐
10.6 SkillSHEET Volume units (doc-6516) ☐
SkillSHEET Volume of a solid constructed from cubic-centimetre blocks (doc-6517) ☐

Video eLessons

10.2 Metric units of length (eles-4549) ☐
Converting units of length (eles-4550) ☐
10.3 Reading scales and measuring length (eles-4551) ☐
10.4 Calculating the perimeter (eles-4552) ☐
Calculating the perimeter of a rectangle and a square (eles-4553) ☐
Perimeter (eles-1874) ☐
10.5 Metric units of area (eles-4554) ☐
Calculating the area of a rectangle (eles-4555) ☐
Calculating the area of a triangle (eles-4556) ☐
Area of a parallelogram (eles-4557) ☐
10.6 Calculating the area of composite shapes (eles-4558) ☐
Composite area (eles-1886) ☐
10.7 Volume (eles-4559) ☐
Calculating the volume of a rectangular prism (eles-4560) ☐
10.8 Capacity (eles-4561) ☐
10.9 Prisms (eles-4562) ☐
Plans and views (eles-4563) ☐
Isometric drawing (eles-4564) ☐

Interactivities

10.2 Individual pathway interactivity: Units of measurement and converting units of measurement (int-4355) ☐
Metric units of length (int-4010) ☐
Converting units of length (int-4011) ☐
10.3 Individual pathway interactivity: Reading scales and measuring length (int-4356) ☐
Scales and measuring length (int-4012) ☐
10.4 Individual pathway interactivity: Perimeter (int-4357) ☐
Perimeter (int-4013) ☐
Perimeter of composite shapes (int-4014) ☐
10.5 Individual pathway interactivity: Area (int-4358) ☐
Metric units of area 1 (int-4015) ☐
Metric units of area 2 (int-4016) ☐
Area of a rectangle (int-4017) ☐
Area of a triangle (int-4018) ☐
Area of a parallelogram (int-4019) ☐
10.6 Individual pathway interactivity: Area of composite shapes, using addition and subtraction (int-4359) ☐
Area of composite shapes (int-4020) ☐
10.7 Individual pathway interactivity: Volume of rectangular prisms (int-8470) ☐
Volume (int-4021) ☐
Volume of a rectangular prism (int-4022) ☐
10.8 Individual pathway interactivity: Capacity (int-4361) ☐
Capacity (int-4024) ☐
10.9 Individual pathway interactivity: Plans and views (int-4392) ☐
Prisms (int-4148) ☐
Plans and views (int-4149) ☐
10.10 Crossword (int-2600) ☐
Sudoku puzzle (int-3170) ☐

Teacher resources

There are many resources available exclusively for teachers online.

To access these online resources, log on to **www.jacplus.com.au**.

Answers

Topic 10 Measurement

Exercise 10.1 Pre-test

1. 56.5 cm
2. 0.020 12 km
3. 90 m
4. 1.8 km
5. 46.8 cm
6. 50 m
7. 27 m^2
8. $472.50
9. 112 cm^2
10. 12.72 m^2
11. 48 m^3
12. 7 cm
13. 54 L
14. **a.** ii **b.** iii **c.** v **d.** i **e.** iv
15. **a.** B **b.** A **c.** C **d.** D

Exercise 10.2 Units of measurement

1. **a.** m **b.** km **c.** cm **d.** km **e.** m
2. **a.** m **b.** cm **c.** km **d.** mm
3. A
4. **a.** 2000 m **b.** 7000 m
   c. 5300 m **d.** 660 m
5. **a.** 25 cm **b.** 280 mm
   c. 2000 mm **d.** 70 000 cm
6. **a.** 8 km **b.** 6.5 km
   c. 0.7 km **d.** 0.05 km
7. **a.** 60 m **b.** 0.57 m
   c. 4.5 cm **d.** 2560 cm
8. **a.** 800 000 cm **b.** 101 000 mm
   c. 72 330 mm **d.** 0.030 35 mm
9. D
10. A
11. **a.** 0.0452 km **b.** 0.56 m **c.** 87.5 mm
12. **a.** 60 cm **b.** 309 000 cm **c.** 4.8 cm
13. Sample responses are given here:
    a. the length of tube required to allow a cat to breathe through while in surgery
    b. the circumference of an actor's head so that an old-fashioned hat of the correct size can be made
    c. the length of a piece of milled hardwood required for the tabletop of a new table for a large family
    d. the height of a hill that requires terracing
    e. the length, in paces, of the runway leading to a long jump pit
14. **a.** 868 cm **b.** 10.8 cm
15. Everest: 8.848 km, K2: 8.611 km
16. **a.** 150 cm, 12.5 m, 0.02 km
    b. 0.445 m, 3000 mm, 350 cm
    c. 50 000 mm, 500 m, 50 km
17. **a.** 1.7 m, 1700 cm, 0.17 km
    b. 0.0052 mm, 0.000 052 m, 0.052 cm
    c. 0.909 m, 9000 mm, 990 cm
18. **a.** 375 cm **b.** 10 200 m
    c. 224.2 cm **d.** 155.3 cm
19. **a.** 66 400 m **b.** 410.4 m
    c. 10.4 cm **d.** 1.7 km
20. 828 m
21. 44
22. 216 m
23. 1.593 m
24. Yes, 36 cm
25. 198 cm
26. 2.4 m
27. **a.** **i.** 18 000 000 km
    ii. 1 080 000 000 km
    iii. 25 920 000 000 km
    iv. 9 460 800 000 000 km
    b. Distances in the universe are very big and it would be inconvenient to use kilometres to measure them. The numbers in kilometres would be too large and would make interpreting and even reading distances difficult.
28. 71 428 pins
29. 38
30. 40 cm
31. 215 cm, 105 cm, 155 cm, 170 cm
32. **a.** **i.** 50 rotations
    ii. 100 rotations
    b. **i.** 500 rotations
    ii. 1000 rotations
33. 2 cm × 4 cm, 2 cm × 8 cm, 2 cm × 12 cm, 2 cm × 16 cm
34. 38.5 km

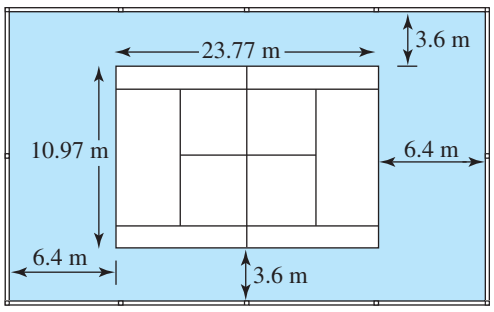
Exercise 10.3 Reading scales and measuring length

1. **a.** 4 cm **b.** 7 cm **c.** 2 cm
2. **a.** 9.5 cm **b.** 6.4 cm **c.** 10.1 cm **d.** 5.8 cm
3. 2.3 units
4. **a.** 45 °F **b.** 34 °C **c.** 26 °C **d.** 10 °C
5. **a.** 45 km/h **b.** 80 km/h **c.** 100 km/h
6. **a.** 1280 mL **b.** 1800 mL
7. 30 °C
8. **a.** 130 °C **b.** 220 °C **c.** 360 °F
9. B
10. C
11. D
12. D
13. B
14. 1.74 m

15. C
16. A
17. B
18. Sample answers include the following:
    a. Measuring a piece of wood
    b. Drawing straight lines
    c. Determining waist size
    d. Measuring garden dimensions
19. The lamppost is about 4 times the height of the car, so it is about 7.2 m high.
20. Measure the thickness of the book using a ruler, then divide the thickness of the book by the number of pages (two sided) in the book to calculate the thickness of each page.
21. 0.2 km
22. 293 cm

Exercise 10.4 Perimeter

1. a. 8 units b. 18 units c. 18 units
   d. 22 units e. 12 units
2. a. 40 cm b. 92 mm
3. a. 30 m b. 44 cm
4. 74 cm
5. 68 cm
6. 28 cm
7. a. 173 mm b. 2995 cm
8. a. 408 mm b. 180 mm
9. a. 14 433 m b. 17 579 m
10. B
11. a. 156 cm b. 664.2 cm c. 14.8 cm
12. a. $12\frac{9}{10}$ m or 12.9 m
    b. $32\frac{4}{5}$ mm or 32.8 mm
13. 48.5 m
14. 252 cm
15. 325.8 m
16. 139.8 m
17. a. 193 m b. $3667
18. a.



    b. 109.48 m
    c. $4050.76
19. For example, fence construction companies would need to calculate perimeters on a daily basis.
20. 99 cm
21. a. 120 m b. $228 c. $810
    d. 25 posts e. $341.25
    f. i. 1600
       ii. $1680
    g. $4059.25
22. a. 8 different rectangles
    b. Square sides 8 cm
23. $P = 6a - 2b$
24. 6 cm

Exercise 10.5 Area

1. a. cm^2 b. m^2 c. mm^2 d. km^2
2. a. m^2 b. km^2 c. m^2 d. ha
3. a. $14\,cm^2$ b. $10\,cm^2$ c. $10\,cm^2$
   d. $16\,cm^2$ e. $8\,cm^2$
4. a. $9\,cm^2$ b. $6\,cm^2$ c. $9\frac{1}{2}\,cm^2$
   d. $12\,cm^2$ e. $10\,cm^2$
5. A
6. C
7. C
8. a. $15\,cm^2$ b. $14\,km^2$ c. $10\,m^2$
9. a. $20\,cm^2$ b. $48\,m^2$
10. a. $56\,m^2$ b. $400\,mm^2$
11. a. $72\,cm^2$ b. $76\,m^2$
12. a. $135\,mm^2$ b. $686\,mm^2$
13. a. $4\,cm^2$ b. $3\,cm^2$ c. $40.5\,cm^2$ d. $50\,cm^2$
14. C
15. A
16. A
17. a. $416\,cm^2$ b. $3.125\,m^2$ c. $2.4\,m^2$ d. $493\,mm^2$
18. a. $583\,cm^2$ b. $600\,km^2$
    c. $337.5\,cm^2$ d. $152\,cm^2$
19. $28.14\,mm^2$
20. C
21. $200\,000\,m^2$
22. a. $16\,000\,000\,000\,m^2$
    b. 1 600 000 hectares
23. $17.5\,m^2$
24. $9.66\,m^2$
25. a. $7.5\,m^2$ b. 15 boxes c. $528
26. $141.64
27. $2560
28. It would be cheaper to use the 70 cm × 70 cm concrete pavers.
29. $88.8\,m^2$
30. $104\,m^2$, $1300
31. $4920\,km^2$
32. $6000\,cm^2$ ($0.6\,m^2$)
33. $135\,m^2$
34. $12.6\,m^2$

35. 126 m^2
36. Length 9 cm, width 4 cm
37. Two sides of the fencing are 6 m long and the other side is 12 m, providing an area of 72 cm^2.

Exercise 10.6 Area of composite shapes

1. a. 81 cm^2 b. 5 m^2 c. 16 cm^2
2. a. 56 cm^2 b. 588 cm^2 c. 13.5 m^2
3. a. 48 m^2 b. 325 m^2
4. 13.05 m^2
5. 39.28 m^2
6. 14.25 m^2
7. a. 27 m^2 b. $675
8. $2157.60 (rounded to the nearest 5 cents)
9. 75 m^2
10. 39 m^2
11. a. 22 cm^2
    b. 22 cm^2
    c. Sample responses can be found in the worked solutions in the online resources.
12. If your composite shape is made up of two or more simple shapes, it is best to determine the area by addition. If the area of a shape has a section not required (a shaded area), it is best to calculate the total area and then subtract the area not required.
13. a. Square of side length 30 cm
    Three circles of diameter 15 cm
    Two semicircles of diameter 30 cm
    b. Using addition of areas: square + circle of diameter 30 cm (the two equal semicircles form one circle).
    Using subtraction of areas: area calculated in previous step $-3\times$ area of the smaller (coloured) circle.
    c. 1075 cm^2
    d. The area in mm^2 would be 107 500 mm^2. This is more inconvenient to use because it is a larger number, which is harder to interpret and use in further calculations if needed.
14. \$0.15/cm^2
15. The shaded area is $\frac{7}{32}$ of the square.
16. a. i. Two rectangles with length 4 cm and width 1 cm and two parallelograms with length 3 cm and width 0.5 cm
    ii. One square of side length 4 cm, one rectangle with length 2 cm and width 1 cm, one triangle with height 3 cm and base 1 cm and two right-angled triangles with height 3 cm and base 0.5 cm. The last two triangles form a triangle with base 1 cm and height 3 cm.
    b. 11 cm^2

Exercise 10.7 Volume of rectangular prisms

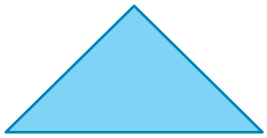
1. a. 8 cm^3 b. 6 cm^3 c. 12 cm^3 d. 48 cm^3
2. B
3. a. 4 cm^3 b. 24 cm^3 c. 15 cm^3 d. 13 cm^3
4. a. 7 cm^3 b. 35 cm^3 c. 14 cm^3 d. 17 cm^3
5. A
6. a. 12 cm^3 b. 12 m^3 c. 6144 cm^3
7. a. 12 cm^3 b. 10 cm^3 c. 10 cm^3
8. a. 192 m^3 b. 270 cm^3 c. 101.25 cm^3
9. D
10. B
11. a. 186 cm^3 b. 136 cm^3
12. a. 189 cm^3 b. 180 cm^3
13. 9690 cm^3
14. 477 750 cm^3
15. a. 20 cm b. 9 cm c. 12 cm
16. a. 2700 cm^3 b. 2 700 000 mm^3
17. 4.875 m^3
18. a. 28.875 cm^3 b. 28 875 mm^3
    c. 176 mm^3 d. 20 075 mm^3
19. 768 m^3
20. 40.8 m^3
21. Each guest receives 267 cm^3 of cake.
22. 2500 m^3
23. 0.65 m^3 more soil is needed (or 2.075 m^3).
24. 2277 cm^3
25. Length 18 cm, width 15 cm and height 10 cm. Volume is 2700 cm^3.
26. 36 000

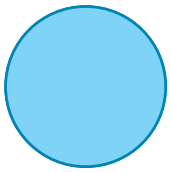
Exercise 10.8 Capacity

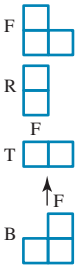
1. a. 2000 mL b. 3 L c. 7 L d. 5.5 L
2. a. 2500 mL b. 32 L c. 35 mL d. 420 000 mL
3. a. 1870 mL b. 22.5 L c. 100 mL d. 0.025 kL
4. a. 750 mL b. 0.0025 kL
    c. 2450 cm^3 d. 78 L
5. a. 40 000 mL = 40 L b. 6000 mL = 6000 cm^3
    c. 5.2 kL = 5.2 m^3
6. D
7. D
8. a. 0.25 L, 2.45 L, 2.5 L, 25 000 mL
    b. 7.65 mL, 760 mL, 0.765 L, 7.60 L
    c. 0.011 L, 0.1 L, 110 mL, 1.1 L
9. 16 bottles
10. 1750 mL (1.75 L)
11. 1620 mL (1.62 L)
12. 6 L
13. 50 doses
14. 225 bottles
15. 9.9 L
16. 4.8 L
17. a. No b. Yes
18. The 185 mL container is the better buy.

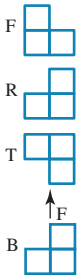
19. The tank overflowed.
20. 616 mL
21. 50.4 L
22. Approximately 27 L (27.09 L)
23. 300 mL
24. 1401.6 L
25. 16.4 kL = 16.4 m^3. An example could be length 2 m, width 2 m, height 4.1 m.

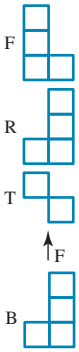
Exercise 10.9 Drawing solids

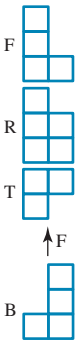
1. a. 
b. 

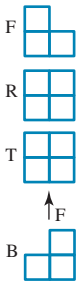
2. a. 
b. 

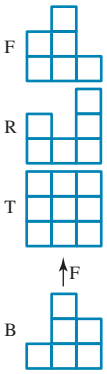
3 a. 

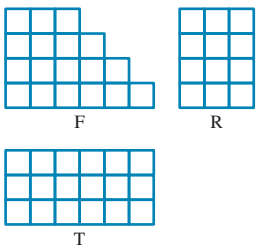
b. 

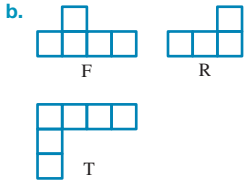
c. 

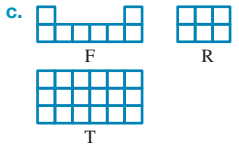
4. a. 

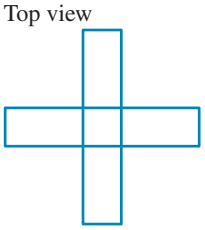
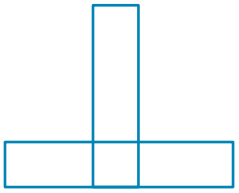
b. 

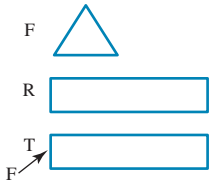
c. 

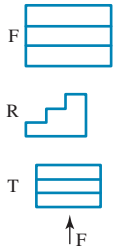
5. a. 

b. 

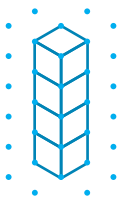
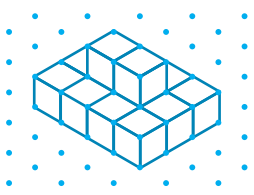
c. 

6. Top view 
Front and side views 

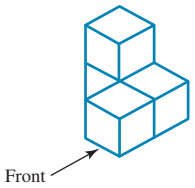
7. a. 

b. 

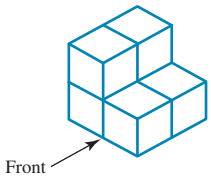
8. a. 
b. 
c. 
d. 

9. a. 
b. 
c. 
d. 

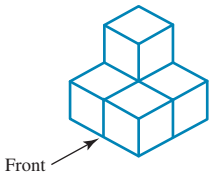
10. a.



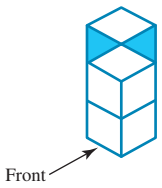
b.



11. a.



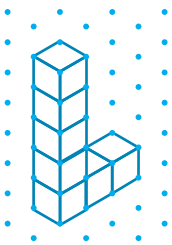
b.



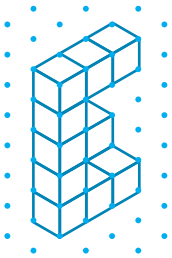
12. D

13. a.

b.



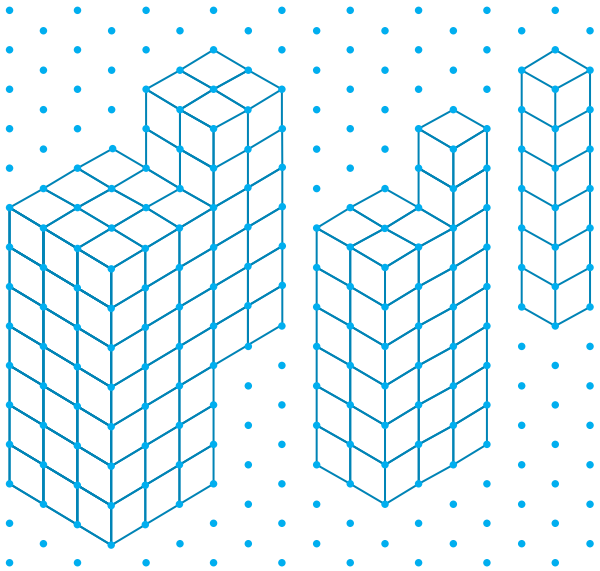
c.



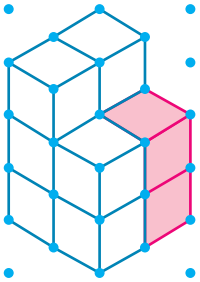
d.

14.

15. A sample response is shown below.

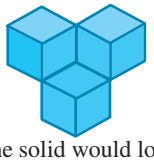


16. The minimum number of cubes that could be used is 8, as shown in blue in the figure. There are two spaces that could be filled with cubes without changing the front or right views (shown in pink); therefore, the maximum number of cubes that could be used is 10.



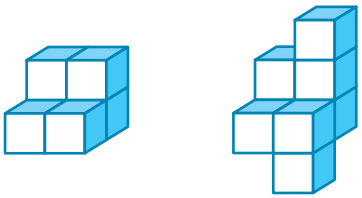
17. a. It would be difficult to construct this solid.

b.

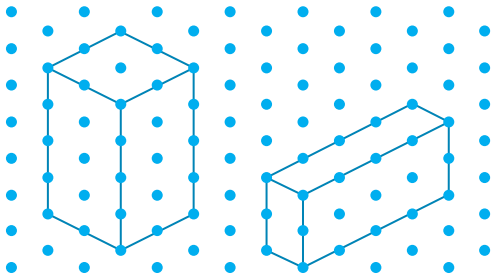


The solid would look like the one shown. The fourth cube is behind the front bottom cube, resting on the surface. The two top cubes have no cubes supporting them.

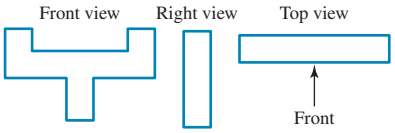
18. An infinite number of shapes because there are no restrictions on the other two views



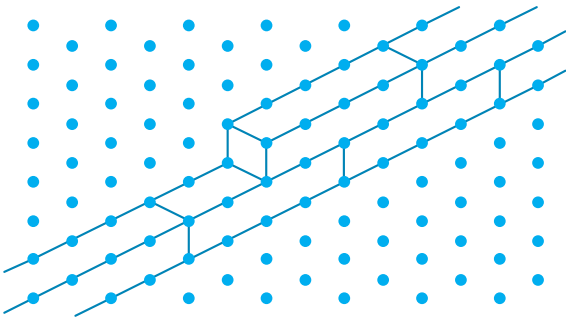
19.



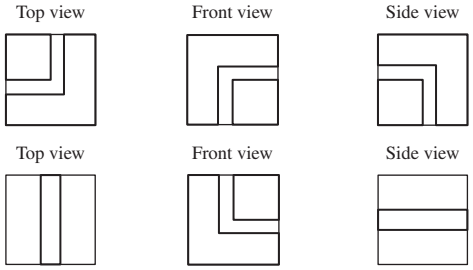
20.



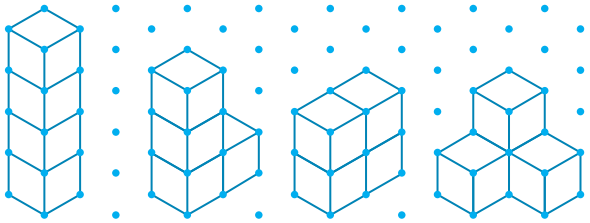
21.



22.



23. The arrangements are shown below.



Project

1. 1 cubit = 0.523 metres

2. A sample response is given here.
Inch — a unit of length used as a measure for display screens, the height of a person or sometimes the thickness of an object
Mile — a unit of length or distance used to measure the distance usually seen on road signs in the US
Furlong — a unit of distance used to measure dimensions of farmland and distance in horse racing
Foot — a unit of length used to measure the height of a person or an object
Fathom — a unit of length used to measure the depth of the water, or the length of a fisher's setline

3. A sample response is given here.

Basketball:

Baskets:	Inches Rings are 18 inches in inside diameter, with white cord 12-mesh nets, 15 to 18 inches in length.
Height of basket:	Feet 10 feet (upper edge)
Circumference of ball:	Inches Not greater than 30 inches and not less than $29\frac{1}{2}$ inches.

Soccer:

Goals:	Yards/feet/inches Distance between posts is 8 yards. Distance from crossbar to the ground is 8 feet.
Penalty area:	Yards Two lines drawn at right angles to the goal line, 18 yards from the inside of each goalpost. Lines extend into playing field for 18 yards and are joined by a line drawn parallel with the goal line.

Exercise 10.10 Review questions

1. a. Kilometres or metres
b. Centimetres
c. Millimetres

2. a. 0.56 m **b.** 0.023 km **c.** 1700 cm
d. 750 000 mm **e.** 2090 mm

3. a. 0.068 m **b.** 2.25 cm **c.** 6.3 m
d. 82 000 km **e.** 0.59 cm

4. 0.004 45 km, 455 cm, 44.5 m, 455 000 mm

5. a. 51 200 m (51.2 km)
b. 3700 cm (37 m)

6. 80 kg

7. 7 m

8. a. m^2 **b.** km^2 **c.** mm^2
d. ha **e.** km^2

9. a. $12\ cm^2$ **b.** $13\ cm^2$ **c.** $2\ cm^2$
d. $5\ cm^2$ **e.** $6\frac{1}{2}\ cm^2$

10. $15\ cm^2$

11. a. $150\ m^2$ **b.** $6\ cm^2$ **c.** $2914\ mm^2$

12. a. $9\ cm^2$ **b.** $19\ cm^2$ **c.** $52\ cm^2$

13. a. $9\ cm^2$ **b.** $380\ cm^2$ **c.** $11\ cm^2$

14. a. $627\ cm^2$ **b.** $96\ m^2$ **c.** $1344\ cm^2$

15. a. $16\ m^2$ **b.** $432\ mm^2$

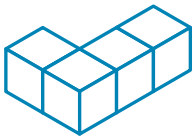
16. a. $87.5\ cm^2$ **b.** $41\ cm^2$

17. a. $18\ cm^3$ **b.** $30\ cm^3$
c. $20\ cm^3$ **d.** $28\ cm^3$

18. a.

b.

19. a.



b.

20. $72\ cm^3$

21. $112\ cm^3$

22. a. 8000 mL **b.** 420 mL
c. 3.3 L **d.** 1012 mL

23. a. 4300 L **b.** 3.4 L
c. 4.755 kL **d.** 0.432 L

24. 25 cm

25. **a.** 46 cm **b.** 20 cm
c. 191 mm (19.1 cm) **d.** 21 cm (210 mm)

26. 243 m

27. 870 cm

28. $582.40

29. 3.6 m^2

30. 0.72 m^2

31. **a.** 28 cm **b.** 8.5 cm

32. 4.9 L

33. **a.** 1725 mL (1.725 L)
b. 8 glasses

34. The perimeter is 46.

35. 32 cm^2

36. 39.6 cubic metres

37. 10 cm by 30 cm

38. **a.** Area of path is 78 m^2.
b. 4680 bricks are needed.

39. Possible side dimensions: $9 \times 1; 8 \times 2; 7 \times 3; 6 \times 4; 5 \times 5$.
Largest area is 25 square units.

40. 8 cm

41. **a.**  **b.**